

PHYSICS

1) If number of holes and free electrons in semiconductor are n_p and n_e respectively then :-

- (1) $n_p > n_e$ in intrinsic semiconductor
- (2) $n_p = n_e$ in extrinsic semiconductor
- (3) $n_p = n_e$ in intrinsic semiconductor
- (4) $n_e > n_p$ in intrinsic semiconductor

2)

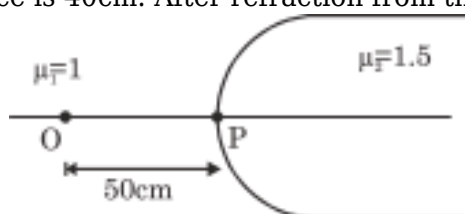
A particle starts from rest with uniform acceleration a . Its velocity after n seconds is v . The displacement of the body in the last two seconds is :

- (1) $\frac{2v(n-1)}{n}$
- (2) $\frac{v(n-1)}{n}$
- (3) $\frac{v(n+1)}{n}$
- (4) $\frac{2v(2n+1)}{n}$

3) A ray of light is incident at 60° on a prism of refracting angle 30° . The emerging ray is at an angle 30° with the incident ray. The value of refractive index of the prism is :

- (1) $\sqrt{3}/2$
- (2) $\sqrt{3}/4$
- (3) $\sqrt{3}$
- (4) $2\sqrt{3}$

4) A point object O is placed at a distance of 50cm from the curved surface as shown in figure. The radius of curvature of the curved surface is 40cm. After refraction from the curved surface the



distance of image from point P will be :

- (1) 200cm
- (2) 300cm
- (3) 400cm
- (4) 500cm

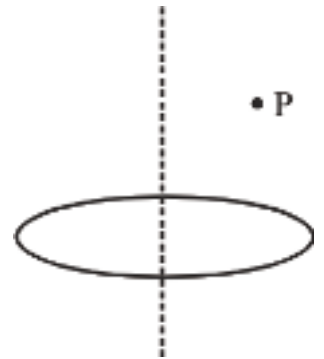
5) This question has Statement 1, Statement 2. Of the four choices given after the statement, choose the one that best describes the two statements.

Statement-1 : Self inductance of a long solenoid of length L , total number of turns N and radius r is less than $\frac{\pi\mu_0 N^2 r^2}{L}$.

Statement-2 : The magnetic induction in the solenoid in Statement 1 carrying current I is $\frac{\mu_0 NI}{L}$ in the middle of the solenoid but becomes less as we move towards its ends.

- (1) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of Statement-1.
- (2) Statement-1 is true, Statement-2 is true and Statement-2 is not the correct explanation of statement-1.
- (3) Statement-1 is true, Statement-2 is false
- (4) Statement-1 is false, Statement-2 is true

6) A current carrying loop is lying on a horizontal plane as shown in figure. Current is anti-clockwise



as seen from above the loop then direction of magnetic field at point P will be

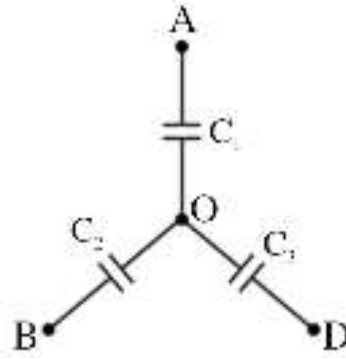
- (1)
- (2)
- (3)
- (4)

7) Meter bridge works on the principle of :-

- (1) Grouping of battery
- (2) Series combination of resistance
- (3) Wheat stone bridge
- (4) Parallel combination of resistance

8) Three uncharged capacitors of capacitance $C_1 = 1\mu\text{F}$, $C_2 = 2\mu\text{F}$ and $C_3 = 3\mu\text{F}$ are connected as shown in figure to one another and to points A, B and D having potential $\phi_A = 10\text{V}$, $\phi_B = 25\text{V}$ and ϕ_D

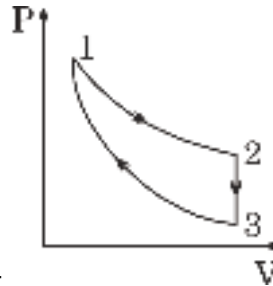
0



= 20 V, Determine the potential (ϕ) at point O :-

- (1) 20 V
- (2) 30 V
- (3) 40 V
- (4) 10 V

9) Three processes form a thermodynamic cycle as shown on P-V diagram for an ideal gas. Process 1 $\rightarrow$ 2 takes place at constant temperature (300K). Process 2 $\rightarrow$ 3 takes place at constant volume. During this process 40J of heat leaves the system. Process 3 $\rightarrow$ 1 is adiabatic and temperature T_3 is



275K. Work done by the gas during the process 3 $\rightarrow$ 1 is :-

- (1) - 40J
- (2) - 20J
- (3) +40J
- (4) +20J

10) 300g of water at 25°C is added to 100 g of ice at 0°C. The final temperature of the mixture is :-

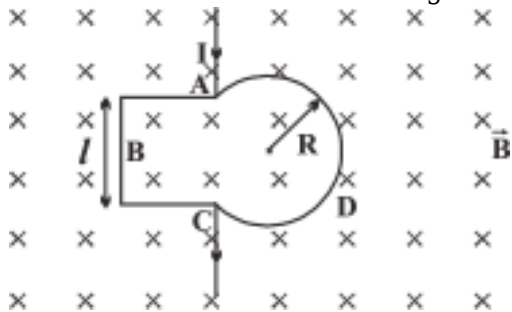
- (1) 0°
- (2) 10°C
- (3) 15°C
- (4) 20°C

11) In Young's double slit experiment, if the widths of the slit are in the ratio 4:9, ratio of intensity of maxima to intensity of minima will be

- (1) 25:1
- (2) 9:4
- (3) 3:2
- (4) 81:16

12) The figure shows a conducting loop ABCDA placed in a uniform magnetic field (strength B)

perpendicular to its plane. The part ABC is the $(3/4)^{\text{th}}$ portion of the square of side length ℓ . The part ADC is a circular arc of radius R. The points A and C are connected to a battery which supply a current I to the circuit. The magnetic force on the loop due to the field B is :-

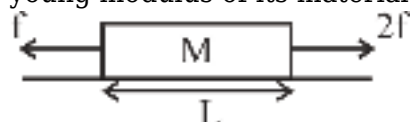


- (1) zero
- (2) $BI\ell$
- (3) $2BIR$
- (4) $\frac{BI\ell R}{\ell + R}$

13) A particle is executing SHM with amplitude A. The displacement of the particle from the mean position when its kinetic energy is equal to its potential energy is

- (1) $\frac{A}{2}$
- (2) $\frac{A}{\sqrt{2}}$
- (3) $\frac{\sqrt{3}A}{2}$
- (4) A

14) A rod of mass 'M' is subjected to force 'f' and '2f' at both the ends as shown in the figure. If young modulus of its material is 'y' and its length is L find total elongation of rod.



- (1) $\frac{f\ell}{2Ay}$
- (2) $\frac{f\ell}{Ay}$
- (3) $\frac{3f\ell}{2Ay}$
- (4) $\frac{4f\ell}{2Ay}$

15) A wide tank of cross-section area A, containing a liquid to a height H, has an orifice at its base of area $\frac{A}{3}$. The initial velocity of top surface of liquid is

- (1) $\sqrt{\frac{gH}{4}}$
- (2) $3\sqrt{\frac{gH}{4}}$
- (3) $\sqrt{\frac{gH}{2}}$
- (4) $\frac{1}{3}\sqrt{\frac{gH}{2}}$

16) The efficiency of a carnot cycle on a monoatomic gas is 50%. The lowest temperature during the cycle is 27°C. If there are 3 mole of gas, what is the change in its internal energy during adiabatic expansion during the cycle ?

- (1) -101.25 J
- (2) 11.25 kJ
- (3) 101.25 J
- (4) -11.25 kJ

17) A plastic ball is rising in water with terminal speed v . If we use a different plastic whose density is double that of the original ball but still less than density of water, keeping the radius same, the terminal speed would be :-

- (1) Doubled
- (2) Half
- (3) More than original value
- (4) Less than original value

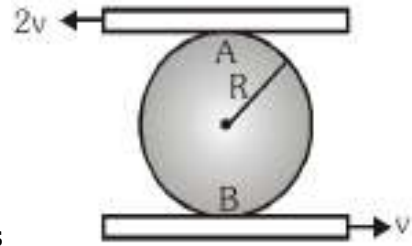
18) A coil is suspended in a uniform magnetic field, with the plane of the coil parallel to the magnetic lines of force. When a current is passed through the coil it starts oscillating; it is very difficult to stop. But if an aluminium plate is placed near to the coil, it stops. This is due to :-

- (1) Electromagnetic induction in the aluminium plate giving rise to electromagnetic damping
- (2) Development of air current when the plate is placed
- (3) Induction of electrical charge on the plate
- (4) Shielding of magnetic lines of force as aluminium is a paramagnetic material

19) In a potentiometer, there are 10 identical cells (E , r -each) arranged in series in primary circuit. A cell of emf E_0 and internal resistance r_0 is balanced at ℓ_1 length of the potentiometer wire. Now, the polarity of two cells is reversed in primary circuit. The same cell of emf E_0 now gets balanced at ℓ_2 then ℓ_1/ℓ_2 is :-

- (1) 3/5
- (2) 5/3
- (3) 1/2
- (4) 2/1

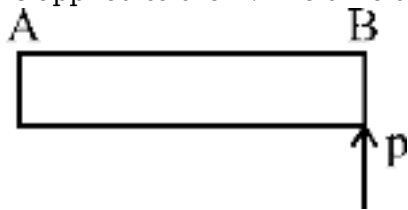
20) A disc of the radius R is confined to roll without slipping at A and B. If the plates have the



velocities v and $2v$ as shown, the angular velocity of the disc is

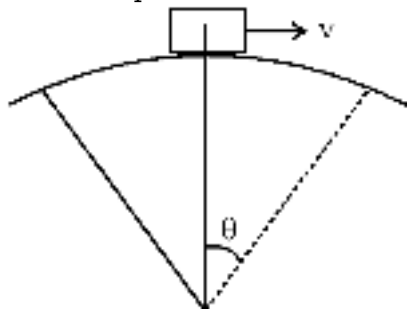
- (1) $\frac{3v}{2R}$ Anticlockwise
- (2) $\frac{3v}{2R}$ Clockwise
- (3) $\frac{v}{2R}$ Anticlockwise
- (4) $\frac{v}{2R}$ Clockwise

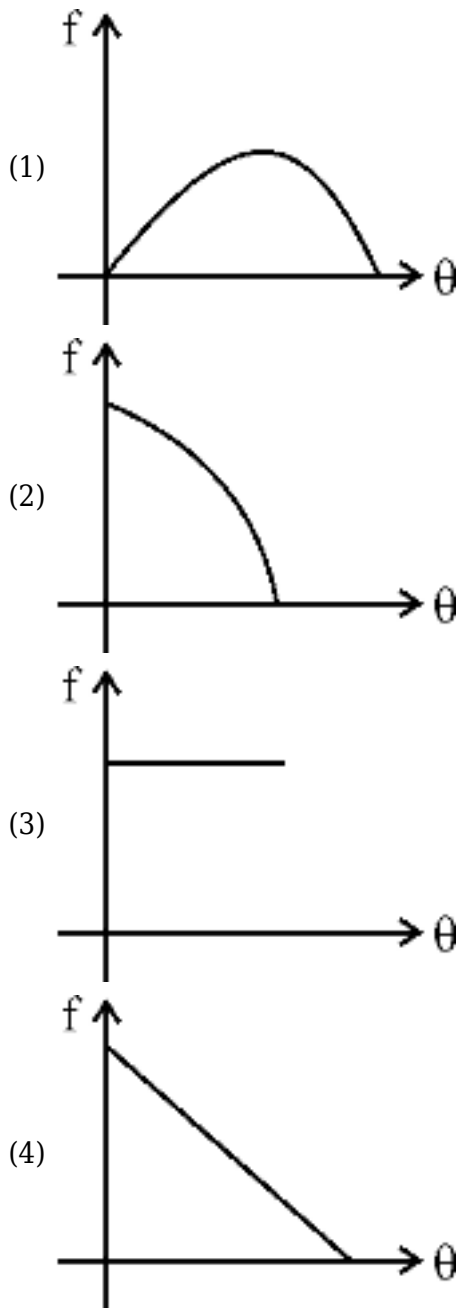
21) A uniform rod AB of length ℓ and mass m is at rest on a smooth horizontal surface. An impulse p is applied to the B. The time taken by the rod to turn through a right angle is:



- (1) $\frac{2\pi m\ell}{p}$
- (2) $\frac{2\pi p}{m\ell}$
- (3) $\frac{\pi m\ell}{p}$
- (4) $\frac{\pi m\ell}{12p}$

22) A particle move on an circular overbridge with constant speed. The friction coefficient varies so that the speed remains constant. Which of the following graph best shows the magnitude of friction.





23) A sound source of frequency 512 Hz approaches a stationary observer with a velocity of 36 km/hr. The speed of sound is 330 m/s. What is the frequency heard by the observer ?

- (1) 522 Hz
- (2) 528 Hz
- (3) 524 Hz
- (4) 532 Hz

24)

An elevator with passenger has total mass of 80 kg and moves slowly a vertical distance of 20 m in 10 sec. What is the average power delivered by elevator in lifting this mass :-

- (1) $1.57 \times 10^2 \text{ W}$
- (2) $1.57 \times 10^4 \text{ W}$

(3) $1.57 \times 10^3 \text{ W}$

(4) $1.57 \times 10^5 \text{ W}$

25) If $N_t = N_0 e^{-\lambda t}$ then number of disintegrated atoms between t_1 to t_2 ($t_2 > t_1$) will be :-

(1) $N_0 [e^{\lambda t_2} - e^{\lambda t_1}]$

(2) $N_0 [-e^{\lambda t_2} - e^{-\lambda t_1}]$

(3) $N_0 [e^{-\lambda t_1} - e^{-\lambda t_2}]$

(4) none

26) A man slides down a light rope whose breaking strength is η times his weight ($\eta < 1$). What should be his maximum acceleration so that the rope just breaks?

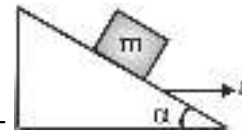
(1) ηg

(2) $g/(1 + \eta)$

(3) $g(1 - \eta)$

(4) $g/(2 - \eta)$

27) A block is kept on a frictionless inclined surface with angle of inclination α . The incline is given



are acceleration 'a' to keep the block stationary. Then a is equal to :-

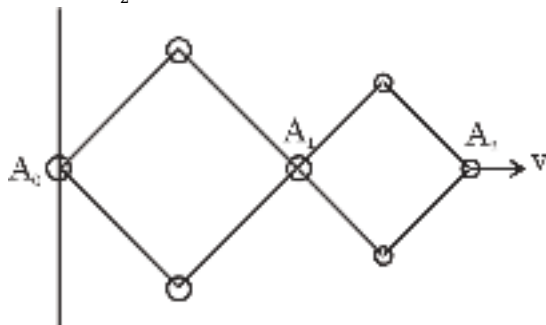
(1) $\frac{g}{\tan \alpha}$

(2) $g \operatorname{cosec} \alpha$

(3) g

(4) $g \tan \alpha$

28) The given construction as shown in figure consists of two rhombus with the side ratio 5 : 4. The vertex A_2 moves in the horizontal direction with a velocity v . Find the velocity of A_1 .

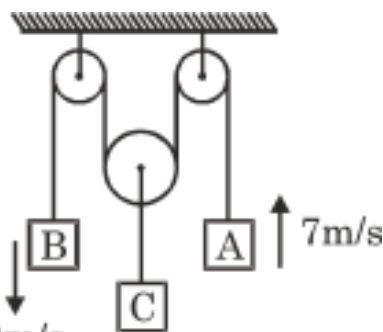


(1) $\frac{9}{5}v$

(2) $\frac{5}{9}v$

(3) $\frac{4}{5}v$

(4) $\frac{5}{4}v$



29) What will be the velocity of block "C" :- 3m/s

- (1) 4 m/s down
- (2) 4 m/s up
- (3) 2 m/s up
- (4) 2 m/s down

30) The energy gap in a semiconductor is of the order of :-

- (1) 1 eV
- (2) 5 eV
- (3) 10 eV
- (4) 15 eV

CHEMISTRY

- 1) A. Phenyl methanamine
- B. N,N-Dimethylaniline
- C. N-Methyl aniline
- D. Benzenamine

Choose the correct order of basic nature of the above amines.

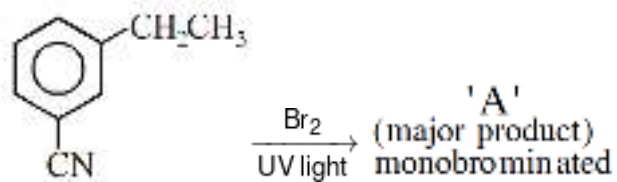
- (1) $A > C > B > D$
- (2) $D > C > B > A$
- (3) $D > B > C > A$
- (4) $A > B > C > D$

2)

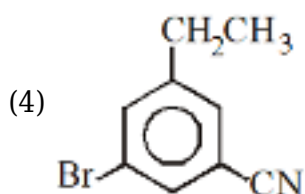
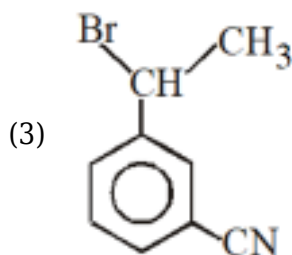
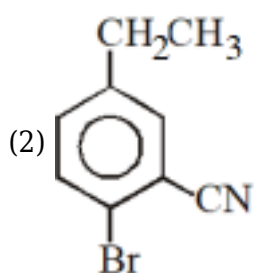
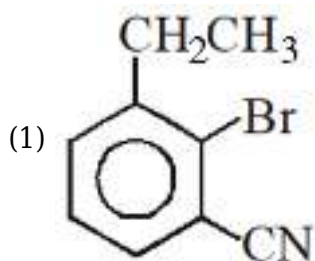
Compound with molecular formula $\text{C}_3\text{H}_6\text{O}$ can show :

- (1) Positional isomerism
- (2) Both positional isomerism and metamerism
- (3) Metamerism
- (4) Functional group isomerism

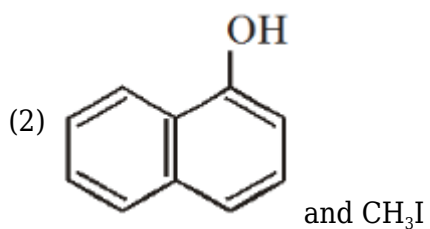
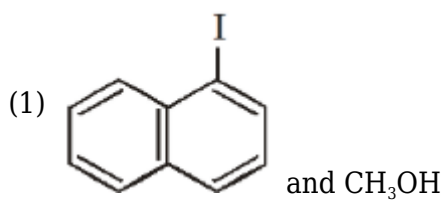
3) For the given reaction :

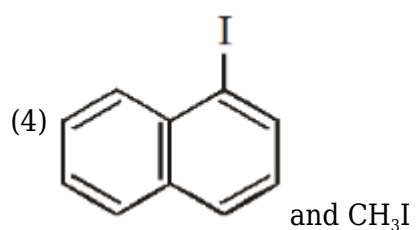
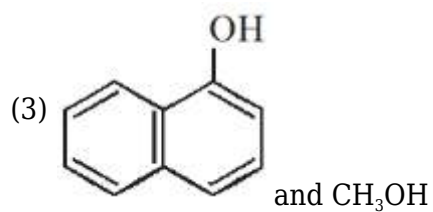


What is 'A'?



4) Main Products formed during a reaction of 1-methoxy naphthalene with hydroiodic acid are:

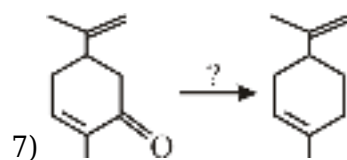
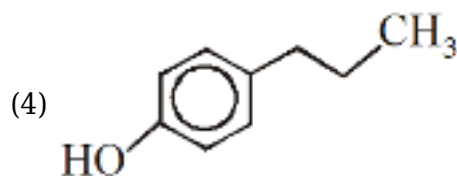
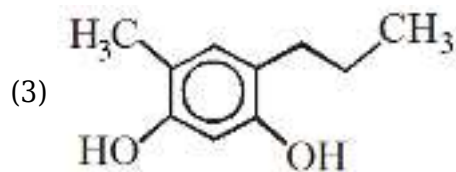
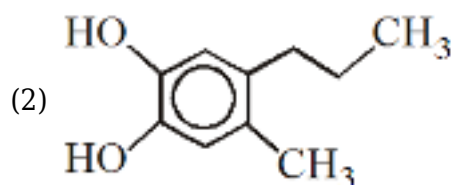
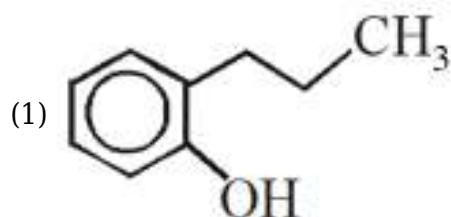




5) Which of the following is Lindlar catalyst ?

- (1) Zinc chloride and HCl
- (2) Cold dilute solution of KMnO_4
- (3) Sodium and Liquid NH_3
- (4) Partially deactivated palladised charcoal

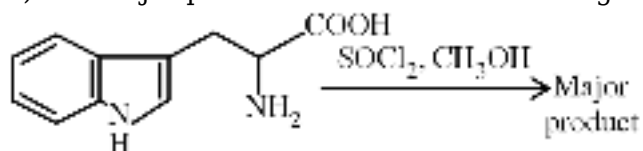
6) Which of the following compound gives pink colour on reaction with phthalic anhydride in conc. H_2SO_4 followed by treatment with NaOH ?



Which of the following reagent is suitable for the preparation of the product in the above reaction ?

- (1) NaBH_4
- (2) $\text{NH}_2\text{-NH}_2/\text{C}_2\text{H}_5\text{O}^\ominus\text{Na}^\oplus$
- (3) Ni/H_2
- (4) Red P + Cl_2

8) The major product formed in the following reaction is :



- (1)
- (2)
- (3)
- (4)

9) An amine on reaction with benzenesulphonyl chloride produces a compound insoluble in alkaline solution. This amine can be prepared by ammonolysis of ethyl chloride. The correct structure of amine is :

- (1)
- (2) $\text{CH}_3\text{CH}_2\text{NH}_2$
- (3) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NHCH}_3$
- (4)

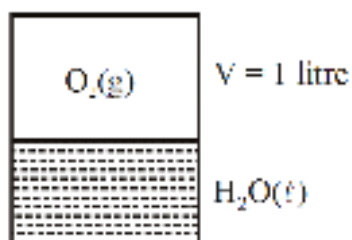
10) Which of the following vitamin is helpful in delaying the blood clotting -

- (1) Vitamin C
- (2) Vitamin B
- (3) Vitamin E
- (4) Vitamin K

11) 1120 ml of ozonised oxygen ($O_2 + O_3$) at 1 atm & 273K weighs 1.76 gm. The reduction in volume on passing this through alkaline pyrogallol solution is -

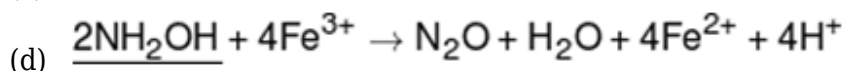
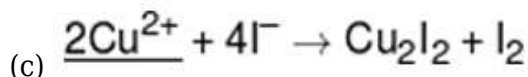
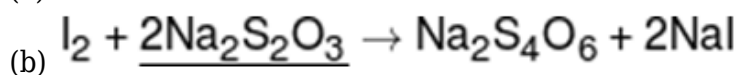
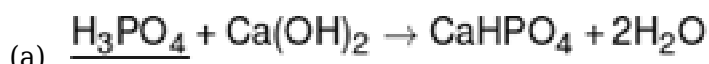
- (1) 896 ml
- (2) 224 ml
- (3) 448 ml
- (4) 672 ml

12) O_2 gas is placed in a 4 litre container containing 3L of liquid water as shown & total pressure exerted by gases is 720 mm Hg. What will be the pressure of $O_2(g)$ if given container is attached to a empty container of 3 litre at same temperature. Given : [V.P. of H_2O at $27^\circ C$ is = 20 mm of Hg].



- (1) 175 mm of Hg
- (2) 350 mm of Hg
- (3) 200 mm of Hg
- (4) 800 mm of Hg

13) In which of the following reactions, the equivalent mass of the underlined species is equal to its molecular mass ?



Correct code is :-

- (1) a, c
- (2) b, c
- (3) a, c, d
- (4) a, b, d

14) In a structure of mixed oxide, oxide ions are in CCP. One fifth of tetrahedral voids are occupied by divalent ion (A^{2+}) while half of the octahedral voids are occupied by trivalent ion (B^{3+}), the formula is :-

- (1) $A_4B_5O_{10}$
- (2) A_2BO_4
- (3) AB_2O_4
- (4) $A_5B_4O_{10}$

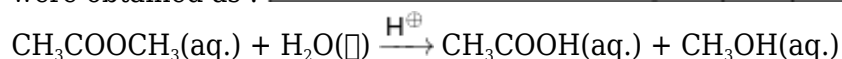
15) Identify the false statement :

- (1) The volume of a solution cannot be less than the sum of volumes of the pure solvent and solute used to prepare the solution (binary solution of two liquids)
- (2) At constant T and P, ΔG_{mix} will be necessarily negative for an ideal solution
- (3) An ideal binary solution ($p_A^0 \neq p_B^0$) cannot form an azeotropic mixture.
- (4) In binary solutions ideality is more of an exception rather than a rule.

16) Methyl acetate was hydrolyzed in HCl aqueous solution at 298K, samples of reaction mixture were withdrawn at different time intervals and titrated with 0.12 N NaOH sample whose volumes

Time(mins)	0	25	∞
Volume of NaOH (mL)	18	30	42

were obtained as : Half- life for the reaction below is-



- (1) 12.5 minutes
- (2) 25 minutes
- (3) 37.5 minutes
- (4) 50 minutes

17) The solubility of $Ba_3(AsO_4)_2$ (molar mass = 690) is 6.9×10^{-2} g/100 mL. What is the value of its K_{sp} ?

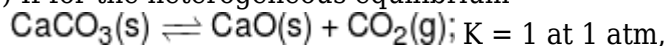
- (1) 1.08×10^{-11}
- (2) 1.08×10^{-13}
- (3) 1.0×10^{-15}
- (4) 6.0×10^{-13}

18) When two mole of an ideal gas $\left(C_{p,m} = \frac{5}{2}R\right)$ heated from 300 K to 600 K at constant pressure. The change in entropy of gas (ΔS) is :

- (1) $\frac{3}{2} R \ln 2$
- (2) $-\frac{3}{2} R \ln 2$
- (3) $5R \ln 2$

(4) $\frac{5}{2} R \ln 2$

19) If for the heterogeneous equilibrium



the temperature is given by:

(1) $T = \frac{\Delta S^\circ}{\Delta H^\circ}$

(2) $T = \frac{\Delta H^\circ}{\Delta S^\circ}$

(3) $T = \frac{\Delta G^\circ}{R}$

(4) $T = \frac{\Delta G^\circ}{\Delta H^\circ}$

20) The solubility product of silver iodide is 8.0×10^{-17} and the standard reduction potential of Ag/Ag^+ electrode is +0.8 volts at 25°C . The standard reduction potential of $\text{Ag}/\text{AgI}/\text{I}^-$ electrode from these data is :

(1) -0.30 V

(2) +0.16 V

(3) +0.10 V

(4) -0.16 V

21) Arrange N, O and S in order of decreasing first electron affinity:

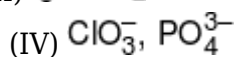
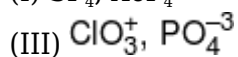
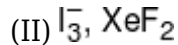
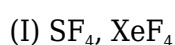
(1) $S > O > N$

(2) $O > S > N$

(3) $N > O > S$

(4) $S > N > O$

22) In which of the following pairs, both the species have the same hybridization state of central atom ?



(1) I, II

(2) II, III

(3) II, IV

(4) I, II, III

23) Number of t_{2g} electrons in $[\text{Co}(\text{NH}_3)_6]^{3+}$ is :-

(1) 0

(2) 1

(3) 2

(4) 3

24) The red colour of ruby is due to

- (1) d-d transition of Cr^{3+} ion in Cr_2O_3 lattice
- (2) d-d transition of Cr^{3+} ion in Al_2O_3 lattice
- (3) Ligand to metal charge transfer transition
- (4) Metal to ligand charge transfer transition

25) Which amongst following is called spin paired complex ?

- (1) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (2) $[\text{CoF}_6]^{3-}$
- (3) $[\text{NiCl}_4]^{2-}$
- (4) All complexes with strong field ligands

26) The group of metals commonly found in the form of sulphide ore-

- (1) Al, Fe, Pb
- (2) Ag, Al, Pb
- (3) Ag, Pb, Cu
- (4) Pb, Al, Na

27) Which of the following reactions does not liberate homonuclear diatomic gas ?

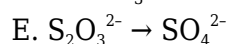
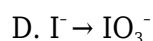
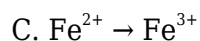
- (1) $\text{KI} + \text{MnO}_2 + \text{conc. H}_2\text{SO}_4 \xrightarrow{\Delta}$
- (2) $\text{NaCl} + \text{MnO}_2 + \text{conc. H}_2\text{SO}_4 \xrightarrow{\Delta}$
- (3) $\text{NaCl} + \text{conc. H}_2\text{SO}_4 \xrightarrow{\Delta} ?$
- (4) $\text{NaBr} + \text{conc. H}_2\text{SO}_4 \xrightarrow{\Delta} ?$

28) A solution of a metal ion when treated with KI gives a red precipitate which dissolves in excess KI to give a colourless solution. Moreover, the solution of metal ion on treatment with a solution of cobalt(II) thiocyanate gives rise to a deep blue crystalline precipitate. The metal ion is

- (1) Pb^{2+}
- (2) Hg^{2+}
- (3) Cu^{2+}
- (4) Co^{2+}

29) Which of the following oxidation reactions are carried out by both $\text{K}_2\text{Cr}_2\text{O}_7$ and KMnO_4 in acidic medium ?

- A. $\text{I}^- \rightarrow \text{I}_2$
- B. $\text{S}^{2-} \rightarrow \text{S}$



Choose the correct answer from the options given below :

- (1) B, C and D only
- (2) A, D and E only
- (3) A, B and C only
- (4) C, D and E only

30) Dinitrogen is a robust compound, but reacts at high altitude to form oxides. The oxide of nitrogen that can damage plant leaves and retard photosynthesis is :

- (1) NO
- (2) NO_3^-
- (3) NO_2
- (4) NO_2^-

ENGLISH PROFICIENCY

1) **Directions** : in each of the following questions, choose the most appropriate alternative to fill in the blanks.

By the time the seminar begins, the participants _____ all the required *documents*.

- (1) have submitted
- (2) will submit
- (3) will have submitted
- (4) had submitted

2) Identify the sentence that maintains correct parallel structure.

- (1) She enjoys reading novels, to paint landscapes, and cooking new recipes.
- (2) She enjoys reading novels, painting landscapes, and cooking new recipes.
- (3) She enjoys to read novels, painting landscapes, and to cook new recipes.
- (4) She enjoys reading novels, painting landscapes, and to cook new recipes.

3) Choose the correct passive form of the sentence:

The committee will review the proposal tomorrow.

- (1) The proposal is reviewed by the committee tomorrow.
- (2) The proposal has been reviewed by the committee tomorrow.
- (3) The proposal will be reviewed by the committee tomorrow.
- (4) The proposal was being reviewed by the committee tomorrow.

4) Choose the meaning that best fits the word “**mitigate**” in the sentence:

The new safety measures were introduced to mitigate the risks associated with chemical handling.

- (1) Eliminate
- (2) Increase
- (3) Reduce
- (4) Ignore

5) Select the correct collocation for the blank:

The principal advised the students to ____ caution while working in the laboratory.

- (1) exercise
- (2) perform
- (3) display
- (4) illustrate

6) Choose the correct meaning of the idiom **“hit the nail on the head.”**

- (1) To exaggerate a situation
- (2) To identify the exact problem
- (3) To make a careless mistake
- (4) To avoid taking responsibility

7) In the following question, some parts have been jumbled up. You are required to rearrange these parts, which are labelled ABCD. Read the following four sentences (A-D). Answer the question that follows:

- A. As a result, digital learning is gradually transforming traditional educational landscapes.
- B. Over the past decade, online platforms have become a significant medium for delivering academic content.
- C. This shift has been supported by advancements in technology and increased accessibility.
- D. Many institutions now integrate digital modules to supplement classroom teaching.

Which of the following options presents the **most coherent paragraph**?

- (1) B-D-C-A
- (2) C-B-A-D
- (3) B-C-D-A
- (4) D-B-C-A

8) **DIRECTIONS** : Choose the order of the sentences marked A, B, C, D and E to form a logical paragraph.

- A. Tasty and healthy food can help you bring out their best.
- B. One minute they are toddlers and next you see them in their next adventure.
- C. Your young ones seem to be growing so fast.
- D. Being their loving custodians, you always want to see them doing well.
- E. Their eyes sparkle with curiosity and endless questions on their tongues.

- (1) DBCEA
- (2) CADEB

(3) CBEDA

(4) ECABD

9) **DIRECTIONS** : Choose the order of the sentences marked A, B, C, D and E to form a logical paragraph.

A. It is hoping that overseas friends will bring in big money and lift the morale of the people.

B. But a lot needs to be done to kick start industrial revival.

C. People had big hopes from the new government.

D. So far government has only given an incremental push to existing policies and programmes.

E. Government is to go for big time reforms, which it promised.

(1) BCDAE

(2) EADCB

(3) DABCE

(4) CDEAB

10) If sentence (B) "The Finance Ministry's warning to potential investors in bitcoin and other Cryptocurrencies has come at a time when a new, seemingly attractive investment area has opened up that few have enough information about." is the first sentence, what is the order of other sentences after rearrangement?

(A) One of the main reasons for this volatility is speculation and the entry into the market of a large number of people lured by the prospect of quick and easy profits.

(B) The Finance Ministry's warning to potential investors in bitcoin and other cryptocurrencies has come at a time when a new, seemingly attractive investment area has opened up that few have enough information about.

(C) A number of investors, daunted by the high price of Bitcoin, have put their money into less well-established and often spurious cryptocurrencies, only to lose it all.

(D) Investment in bitcoin and other cryptocurrencies increased tremendously in India over the past year, but most new users know close to nothing of the technology, or how to verify the genuineness of a particular cryptocurrency.

(E) The price of bitcoin, the most popular of all cryptocurrencies, not only shot up by well over 1000% over the course of the last year but also fluctuated wildly.

(F) The government's caution comes on top of three warnings issued by the Reserve Bank of India since 2013.

(1) CDEFA

(2) EAFDC

(3) DCAEF

(4) ECDAF

LOGICAL REASONING

1) **Direction** : In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

Ocean : Water :: Glacier ?

(1) Refrigerator

- (2) Ice
- (3) Mountain
- (4) Cave

2) **Direction :** In each of the following questions, there are two words to the left of the sign :: which are connected in some way. The same relationship obtains between the third word and one of the four alternatives under it. Find the correct alternative in each question.

PRLN : XZTV :: JLFH : ?

- (1) NPRT
- (2) NRPT
- (3) NTRP
- (4) RTNP

3) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) Wood
- (2) Cork
- (3) Stone
- (4) Paper

4) **Direction :** In each of the following questions, four alternatives are given, out of which three are alike in a certain way while one is different. Choose the odd one.

- (1) FBI
- (2) QMT
- (3) VRY
- (4) HEK

5) Find the next term of series :

3, 15, 4, 16, 5, 17, 6, ?, 7

- (1) 12
- (2) 18
- (3) 15
- (4) 13

6) Find the missing term in the following series.

240, ... 120, 40, 10, 2

- (1) 480
- (2) 240
- (3) 220
- (4) 120

7) **Direction :** In the following question, one term in the number series is wrong. Find out the

wrong term.

24576, 6144, 1536, 386, 96, 24

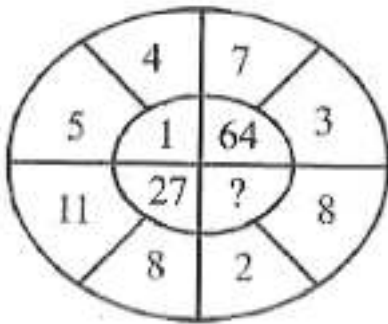
- (1) 96
- (2) 386
- (3) 1536
- (4) 6144

8) **Direction :** Find the missing character in each of the following questions.

72	24	6
96	16	12
108	?	18

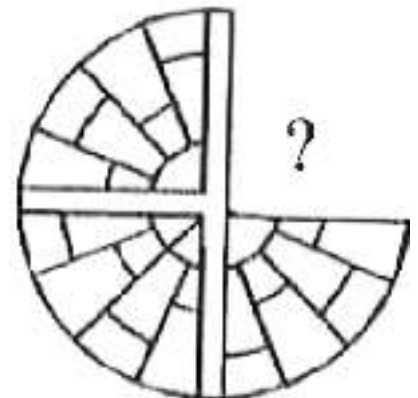
- (1) 12
- (2) 16
- (3) 18
- (4) 20

9) **Direction :** Find the missing character in each of the following questions.

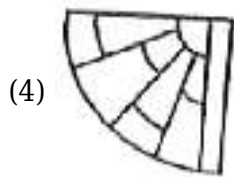
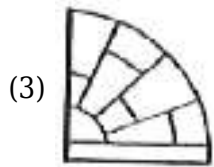
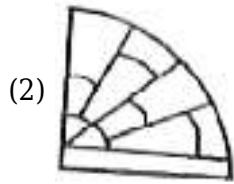
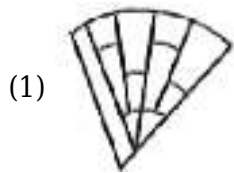


- (1) 0
- (2) 8
- (3) 125
- (4) 216

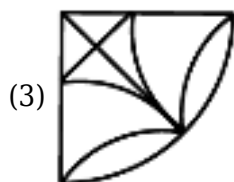
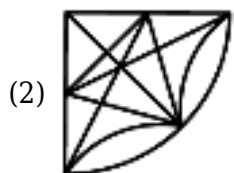
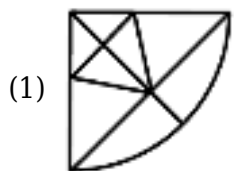
10) **Direction :** In each of the following questions, a part of the figure is missing. Find out from the

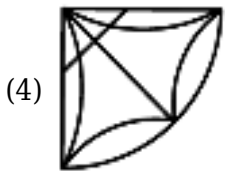


given options (1, 2, 3 and 4) the right figure to fit in the missing place.

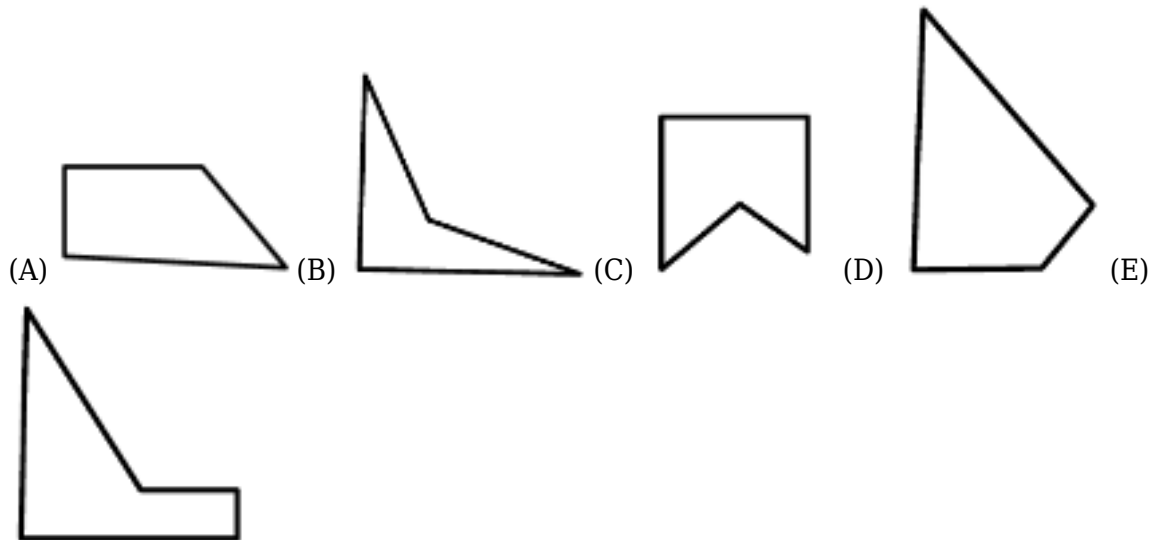


11) **Direction :** In each of the following questions, a part of the figure is missing. Find out from the given options (1, 2, 3 and 4) the right figure to fit in the missing place.



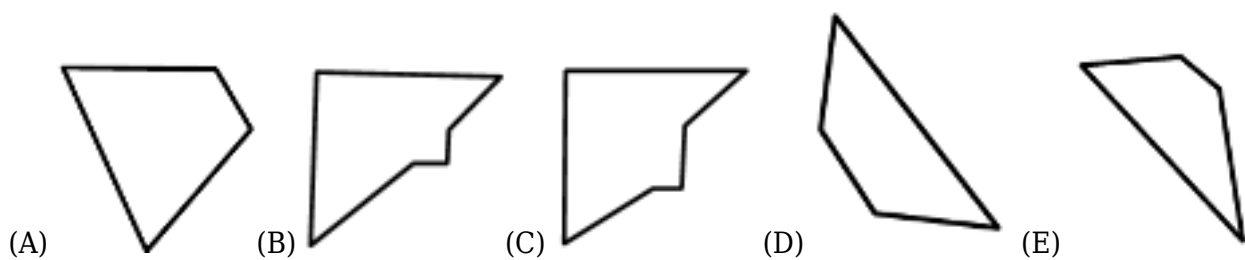


12) **Direction :** In each of the following questions, select that combination of parts (A), (B), (C), (D) and (E) which if fitted together will form a square.



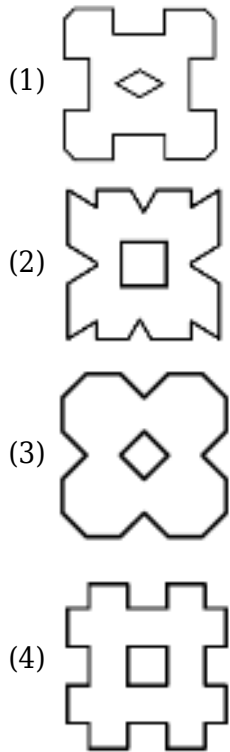
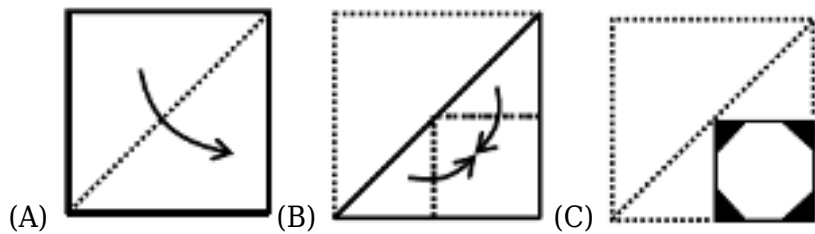
- (1) ACD
- (2) ABD
- (3) BCD
- (4) CDE

13) **Direction :** In each of the following questions, select that combination of parts (A), (B), (C), (D) and (E) which if fitted together will form a square.

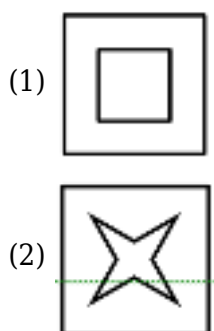
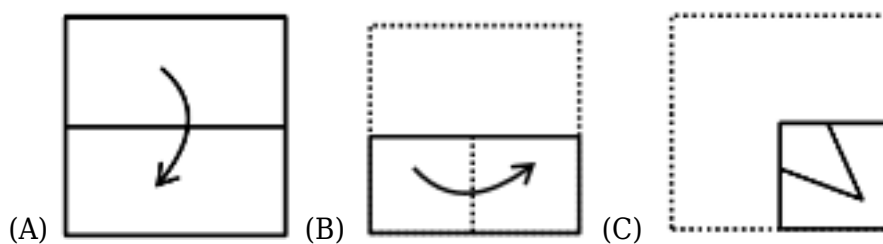


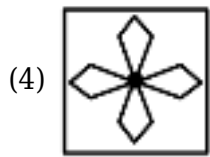
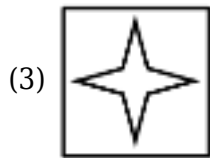
- (1) ABC
- (2) ABD
- (3) BCD
- (4) CDE

14) **Direction :** In each of the following questions a set of three figures A, B and C showing a sequence of folding of a piece of paper. Fig. (C) shows the manner in which the folded paper has been cut. These three figures are followed by four answer figures from which you have to choose a figure which would most closely resemble the unfolded form of fig, (C).

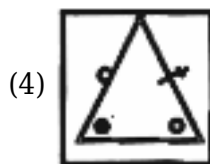
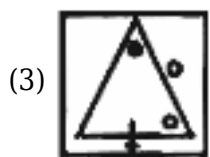
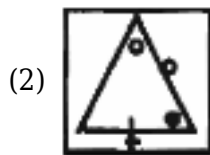
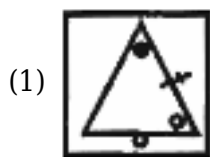
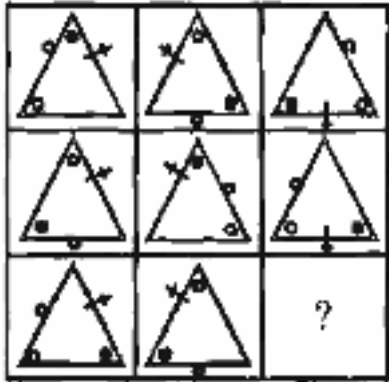


15) **Direction :** In each of the following questions a set of three figures A, B and C showing a sequence of folding of a piece of paper. Fig. (C) shows the manner in which the folded paper has been cut. These three figures are followed by four answer figures from which you have to choose a figure which would most closely resemble the unfolded form of fig, (C).

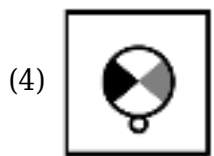
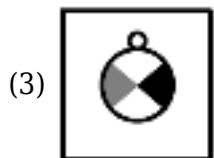
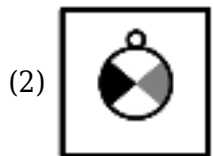
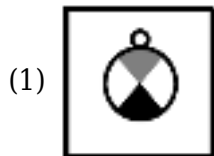
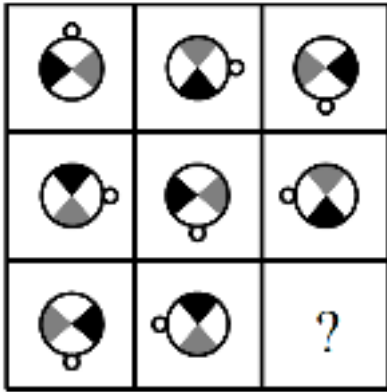




16) **Directions :** In each of the following questions, select the answer figure that will fit in the blank space in the question figure, maintaining the pattern in the proper sequence.

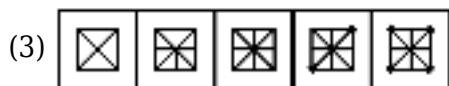
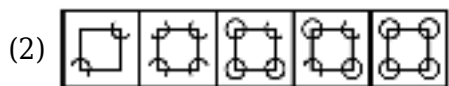
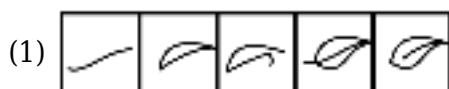


17) **Directions :** In each of the following questions, select the answer figure that will fit in the blank space in the question figure, maintaining the pattern in the proper sequence.



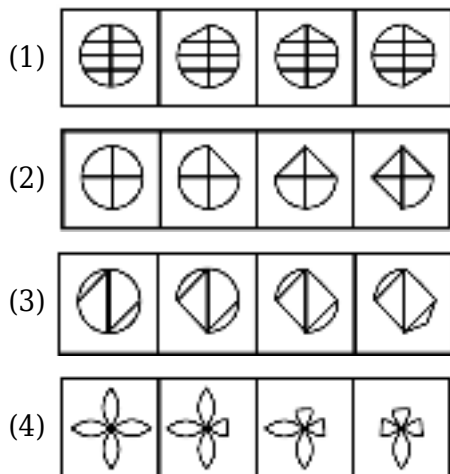
18) **Direction :** Each of the following questions contains four rows of figures. As four alternatives. Each row contains four of five different designs. You have to study carefully each row and judge which series of figures follows the stated rule exactly.

Rule : The series becomes complex as it proceeds.



19) **Direction :** Each of the following questions contains four rows of figures. As four alternatives. Each row contains four of five different designs. You have to study carefully each row and judge which series of figures follows the stated rule exactly.

Rule : Sectors get converted to triangles one by one.



20) **Direction :** Read the following information carefully to answer these questions. The conditions for selecting candidates for interview for recruitment of Medical Representative for a company :

The candidate must :

- (A) be a graduate in science with Chemistry and Botany and / or Zoology.
- (B) have 60% and above at SSC and 50% and above at graduation.
- (C) not be more than 25 years of age as on 1st January, 1997.
- (D) have at least represented school / college in any inter school / collage competition.
- (E) have passed the selection test with 55% and above marks.
- (F) enclose recommendation of two persons who are not his / her relatives.

However, in the case of a candidate who fulfills all other criteria except :

- (I) A above, but has passed M.Sc. in Chemistry with 60% or above marks, should be considered for waiting list for interview.
- (II) B above, should be referred to Manager Administration.
- (III) F above, should be called to meet Manager HRD.

Based on these criteria and information provided below, decide, the course of action in each case.

You are not to assume anything. If the data provided is not adequate to decide the course of action, your answer will be data inadequate. These cases are given to you as on 1st December, 1996.

Ms. Paul Vandana, born on 19th November, 1974 is a post graduate in Chemistry. At graduation she had Chemistry, Zoology and Botany. She had represented her school and college in sports and drama. Her father is a successful doctor. She has passed the selection test with 62% marks and has enclosed recommendation of President and Vice-President of the Chemist's Association.

- (1) To be called for interview
- (2) Data inadequate
- (3) Not to be called for interview
- (4) To be waitlisted

MATHEMATICS

1) $5^{\log x} = 50 - x^{\log 5}$ then $x =$

- (1) e
- (2) 10^2

(3) 10

(4) 5

2) If α and β are roots of equation $x^2 - 7x + 1 = 0$ then $\frac{1}{(\alpha-7)^2} + \frac{1}{(\beta-7)^2}$ is

(1) 47

(2) 49

(3) 55

(4) 59

3) Let ' α ' and ' β ' are the roots of the equation $x^2 - 12x - 3 = 0$ and $a_n = \alpha^n - \beta^n$, $n \in \mathbb{N}$, then the value of $\frac{a_{2023} - 3a_{2021}}{2a_{2022}}$ is

(1) 5

(2) 6

(3) 8

(4) 9

4) The least positive integer n such that $1 - \frac{2}{3} - \frac{2}{3^2} - \dots - \frac{2}{3^{n-1}} < \frac{1}{100}$, is :

(1) 7

(2) 4

(3) 5

(4) 6

5) a, b, c are in A.P. and a^2, b^2, c^2 are in G.P. If $a < b < c$ and $a + b + c = \frac{3}{2}$ then $a =$

(1) $\frac{1}{2\sqrt{2}}$

(2) $\frac{1}{2\sqrt{3}}$

(3) $\frac{1}{2} + \frac{1}{\sqrt{2}}$

(4) $\frac{1}{2} - \frac{1}{\sqrt{2}}$

6) The values of θ satisfying

$3 \cos^2 \theta - 2\sqrt{3} \sin \theta \cos \theta - 3 \sin^2 \theta = 0$ are:

(1) $n\pi - \frac{2\pi}{3}, n\pi + \frac{\pi}{6}$

(2) $n\pi - \frac{\pi}{3}, n\pi + \frac{\pi}{6}$

(3) $2n\pi - \frac{\pi}{3}, n\pi$

(4) $2n\pi + \frac{\pi}{3}, n\pi$

7) If $\cos \theta = \frac{a \cos \phi + b}{a + b \cos \phi}$, then $\tan^2 \frac{\theta}{2}$ is equal to :-

(1) $\left(\frac{a-b}{a+b} \right) \tan^2 \frac{\phi}{2}$

(2) $\left(\frac{a+b}{a-b} \right) \cos^2 \frac{\phi}{2}$

(3) $\left(\frac{a-b}{a+b} \right) \sin^2 \frac{\phi}{2}$

(4) $\left(\frac{a-b}{a+b} \right) \operatorname{cosec}^2 \frac{\phi}{2}$

8) Let $f(x) = \begin{vmatrix} \cos x & \cos^2 x & \cos^4 x \\ \cos 3x & \cos^2 3x & \cos^4 3x \\ \cos 5x & \cos^2 5x & \cos^4 5x \end{vmatrix}$, then $\int_0^\pi f(x) dx$ equals :

(1) 9

(2) 18

(3) 27

(4) None of these

9) The set of all values of λ for which the system of linear equations.

$$x - 2y - 2z = \lambda x$$

$$x + 2y + z = \lambda y$$

$$-x - y = \lambda z$$

has a non-trivial solution.

(1) contains more than two elements

(2) is a singleton

(3) is an empty set

(4) contains exactly two elements

10) A triangle has a vertex at (1, 2) and the mid points of the two sides through it are (-1, 1) and (2, 3). Then the centroid of this triangle is :

(1) $\left(\frac{1}{3}, 1\right)$

(2) $\left(\frac{1}{3}, 2\right)$

(3) $\left(1, \frac{7}{3}\right)$

(4) $\left(\frac{1}{3}, \frac{5}{3}\right)$

11) If a circle (passes through the point (a, b)) and cuts the circle $x^2 + y^2 = 4$ orthogonally, then the equation of the locus of its centre is

(1) $2ax + 2by - (a^2 + b^2 + 4) = 0$

(2) $2ax + 2by - (a^2 - b^2 + 4) = 0$

(3) $x^2 + y^2 - 3ax - 4by + (a^2 + b^2 - 4) = 0$

(4) $x^2 + y^2 - 2ax - 3by + (a^2 - b^2 - 4) = 0$

12) The slope of the line touching both the parabola $y^2 = 8x$ and $x^2 = -64y$ is:

(1) $\frac{1}{8}$

(2) $\frac{1}{16}$

(3) $\frac{2}{3}$

(4) $\frac{1}{2}$

13) The minimum value of the segment of a tangent to the ellipse $\frac{x^2}{12321} + \frac{y^2}{1234321} = 1$ intercepted by the coordinate axes is

(1) 1222

(2) 1223

(3) 1322

(4) 1323

14) The equation of the hyperbola whose foci are (0, -3) and (0, 3) and eccentricity is 3 is given by:-

(1) $x^2 - 8y^2 = 8$

(2) $-x^2 + 8y^2 = 8$

(3) $8x^2 - y^2 = 8$

(4) $-8x^2 + y^2 = 8$

15) The numerically greatest term in the expansion of $(2x + 5y)^{34}$ when $x = 3$ & $y = 2$ is

(1) T_{21}

(2) T_{22}

(3) T_{23}

(4) T_{24}

16) How many numbers can be formed by using digits 0, 1, 2, 3, 5, 6, 7, 8, 9 which lie between 3000 to 7000 and divisible by 5, if repetition is not allowed :-

(1) 210

(2) 84

(3) 252

(4) None

17)

If $f(x) = \sin \left\{ \log_e \left(\frac{\sqrt{4-x^2}}{1-x} \right) \right\}$, $x \in \mathbb{R}$, then domain of $f(x)$ are given by -

(1) $(-2, 1)$

(2) $(-\infty, -2) \cup (1, \infty)$

(3) $(0, 1)$

(4) None of these

18) $\sin^{-1} \left(\sin \left(\frac{\tan^{-1} 1 + \tan^{-1} 2 + \tan^{-1} 3}{\cot^{-1} 1 + \cot^{-1} 2 + \cot^{-1} 3} \right) \right) = ?$

(1) 0

(2) $\pi - 2$

(3) $2 - \pi$

(4) 2

19) The value of $\lim_{x \rightarrow 2} \frac{\sqrt{1 + \sqrt{2+x}} - \sqrt{3}}{x-2}$ is :-

(1) $\frac{1}{8\sqrt{3}}$

(2) $\frac{1}{4\sqrt{3}}$

(3) 0

(4) None

20) Let
$$g(x) = \begin{cases} 3x^2 - 4\sqrt{x} + 1 & \text{for } x < 1 \\ ax + b & \text{for } x \geq 1 \end{cases}$$

If $g(x)$ is continuous and differentiable for all numbers in its domain then -

- (1) $a = b = 4$
- (2) $a = b = -4$
- (3) $a = 4$ and $b = -4$
- (4) $a = -4$ and $b = 4$

21) Let $f(x) = \cos 2x \cdot \cos 4x \cdot \cos 6x \cdot \cos 8x \cdot \cos 10x$ and $M = \lim_{x \rightarrow 0} \left(\frac{1 - (f(x))^3}{5 \tan^2 x} \right)$, where M is finite, then the value of $(\sqrt{M-2} + 1)$

- (1) 2
- (2) 5
- (3) 8
- (4) 9

22) If the tangent to $y = ax^2 + bx + \frac{7}{2}$ at (1,2) is parallel to normal at (-2,2) on $x^2 - y + 6x + 10 = 0$, then $|a + 2b|$ is equal to

- (1) 0
- (2) 1
- (3) 4
- (4) 5

23) Number of solution of the equation $3 \tan x + x^3 = 2$ in $\left(0, \frac{\pi}{4}\right)$ is

- (1) 0
- (2) 1
- (3) 2
- (4) 3

24) Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a function such that $f(x) = x^3 + x^2 f'(1) + x f''(2) + f'''(3)$, $x \in \mathbb{R}$, Then $f(2)$ equal :

- (1) 8
- (2) -2
- (3) -4
- (4) 30

25) If $\int f(x) dx = F(x)$, then $\int x^3 f(x^2) dx$ is equal to:

- (1) $\frac{1}{2} \left[x^2 F(x^2) - \int F(x^2) d(x^2) \right] + C$
- (2) $\frac{1}{2} \int \left[x^2 F(x^2) - F(x^2) dx \right] + C$

(3) $\frac{1}{2} \left[x^2 F(x^2) - \frac{1}{2} \int F(x^2) dx \right] + C$

(4) None of these

26) $\int_{-\pi/2}^{\pi/2} (\sin^2 x - \sin^4 x) (\sin x - \cos x) dx$ is equal to

(1) $4/15$

(2) 0

(3) $-4/15$

(4) $2/15$

27) The solution of differential equation $(2y + xy^3)dx + (x + x^2y^2) dy = 0$ is

(1) $x^2y + \frac{x^3y^3}{3} = c$

(2) $xy^2 + \frac{x^3y^3}{3} = c$

(3) $x^2y + \frac{x^4y^4}{4} = c$

(4) None of these

28) Area enclosed between the curves $|y| = 1 - x^2$ and $x^2 + y^2 = 1$ is

(1) $\frac{3\pi - 8}{3}$ sq. units

(2) $\frac{\pi - 8}{3}$ sq. units

(3) $\frac{2\pi - 8}{3}$ sq. units

(4) None of these

29) If $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 4 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 8 \\ 0 & 1 \end{bmatrix} \dots (n\text{-matrix}) = \begin{bmatrix} 1 & 511 \\ 0 & 1 \end{bmatrix}$ then n equal to-

(1) 511

(2) 1022

(3) 10

(4) 9

30) If $\hat{a}$, $\hat{b}$ and $\hat{c}$ are unit vectors, then $|\hat{a} - \hat{b}|^2 + |\hat{b} - \hat{c}|^2 + |\hat{c} - \hat{a}|^2$ does not exceed :-

(1) 4

(2) 9

(3) 8

(4) 6

31) The equation of the plane passing through the lines $\frac{x-4}{1} = \frac{y-3}{1} = \frac{z-2}{2}$ and $\frac{x-3}{1} = \frac{y-2}{-4} = \frac{z}{5}$ is :-

- (1) $11x - y - 3z = 35$
- (2) $11x + y - 3z = 35$
- (3) $11x - y + 3z = 35$
- (4) none of these

32)

If the projection of the line $\frac{x}{2} = \frac{y-1}{2} = \frac{z-1}{1}$ on a plane P is $\frac{x}{1} = \frac{y-1}{1} = \frac{z-1}{-1}$. Then the distance of plane P from origin is :-

- (1) $\sqrt{3}$
- (2) $\sqrt{\frac{3}{2}}$
- (3) $\sqrt{6}$
- (4) $\frac{2}{\sqrt{3}}$

33) if $z_1 = 2 + i$, $z_2 = 3 - 2i$, then value of $\left| \frac{2z_2 + z_1 - 5 - i}{2z_1 - z_2 + 3 - i} \right|^2$ is

- (1) 0
- (2) 1
- (3) 2
- (4) 3

34) If $z = \frac{\sqrt{3}}{2} + \frac{i}{2}$, ($i = \sqrt{-1}$) then $(1 + iz + z^5 + iz^8)^9$ is equal to

- (1) -1
- (2) 1
- (3) 0
- (4) $(-1 + 2i)^9$

35) The probability that in a family of 5 members, exactly two members have birthday on sunday is:-

- (1) $\frac{(12 \times 5^3)}{7^5}$
- (2) $\frac{(10 \times 6^2)}{7^5}$

(3) $\frac{2}{5}$

(4) $\frac{(10 \times 6^3)}{7^5}$

36) An instrument consists of three units I, II and III. For instrument to operate either unit I and II or unit I and III must function. Probability of function of units I, II and III are $\frac{3}{5}$, p and $\frac{1}{2}$ respectively. If probability of instrument to operate is $\frac{2}{5}$, then value of $6p$ is

(1) 2

(2) 4

(3) 6

(4) 8

37) Standard deviation of n observation; $x_1, x_2, \dots, x_n$ is '2'. If $\sum_{i=1}^n x_i = 20$ & $\sum_{i=1}^n x_i^2 = 100$, then n equals :

(1) 5 or 15

(2) 10 or 20

(3) 5 or 20

(4) 5 or 10

38) The greatest value of $f(x) = \int_1^x |t| dt$ on the interval $[-1/2, 1/2]$ is :

(1) $3/8$

(2) $1/2$

(3) $-3/8$

(4) $-1/2$

39) If $f(x) = \begin{cases} (px + q) & ; x \leq -1 \\ (px^3 + x + 2q) & ; x > -1 \end{cases}$ differentiable for all $x \in \mathbb{R}$ then ordered pair (p, q) is

(1) $\left(\frac{1}{2}, 1\right)$

(2) $(0, 1)$

(3) $\left(-\frac{1}{2}, 1\right)$

(4) $\left(-\frac{1}{2}, 0\right)$

40) Let a matrix A satisfies $A^2 - 3A + 4I = 0$. If $A^4 = aA + bI$, then $a - b$ is :-

(1) 17

(2) 23

(3) 16

(4) -16

ANSWER KEYS

PHYSICS

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	3	1	3	1	1	3	3	1	1	1	1	2	2	3	1	4	4	1	1	1
Q.	21	22	23	24	25	26	27	28	29	30										
A.	4	1	2	3	3	3	4	2	4	1										

CHEMISTRY

Q.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A.	4	4	3	2	4	1	2	3	4	4	1	1	2	1	1	2	2	3	2	4
Q.	51	52	53	54	55	56	57	58	59	60										
A.	1	3	1	2	1	3	3	2	3	3										

ENGLISH PROFICIENCY

Q.	61	62	63	64	65	66	67	68	69	70
A.	3	2	3	3	1	2	3	3	4	2

LOGICAL REASONING

Q.	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
A.	2	4	3	4	2	2	2	1	4	3	3	1	4	3	2	3	2	3	2	2

MATHEMATICS

Q.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
A.	2	1	2	4	4	2	1	4	2	2	1	4	1	2	2	1	1	2	1	3
Q.	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
A.	4	3	2	2	1	3	1	1	4	2	4	2	2	1	4	1	3	3	3	2

SOLUTIONS

PHYSICS

1) **Question Explanation:** Relating hole and electron concentration.

Concept: Intrinsic Semiconductor Charge Balance

Solution: In an **intrinsic semiconductor**, there are no impurities. The thermal energy causes electrons to jump from the valence band to the conduction band, creating a free electron and a hole for each jump. As a result, the number of free electrons (n_e) is always equal to the number of holes (n_p).

Final Answer: $n_p = n_e$ in intrinsic semiconductor

2)

NO SOLUTION

$$3) \delta = i + e - A$$

$$30 = 60 + e - 30$$

$$e = 0$$

$$\mu = \frac{\sin i}{\sin r_1} = \frac{\sin 60}{\sin 30} = \sqrt{3}$$

$$4) \frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

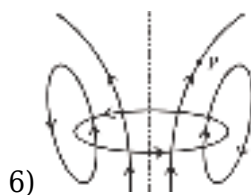
$$\frac{1.5}{v} - \frac{1}{-50} = \frac{1.5 - 1}{40}$$

$$\frac{1.5}{v} = \frac{1}{80} - \frac{1}{50} = -\frac{30}{4000}$$

$$v = -200 \text{ cm}$$

5)

Self explanatory.



7) **Explain Question:**

Identifying the operating principle of a Meter Bridge.

Concept:

Wheatstone Bridge.

Solution:

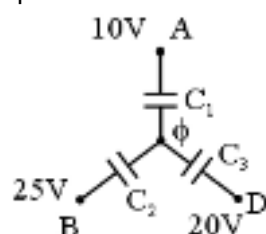
The Meter Bridge is a practical application of the Wheatstone Bridge. It is used to determine an unknown resistance by balancing the bridge on a wire of uniform cross-section, exactly one meter in length.

Final Answer: Option (3)

$$8) E_{q.} = C_1 V_1 + C_2 V_2 + C_3 V_3 = 0$$

$$(25 - \phi)_2 + (20 - \phi)_3 + (10 - \phi)_1 = 0$$

$$\phi = 20V$$



10) Heat required to melt the ice into water

$$= mL = 100 \times 80 = 8000 \text{ Cal}$$

Heat may lost by the water

$$300\text{g at } 25^\circ\text{C into } 0^\circ\text{C water} = 300 \times 1 \times 25 = 7500 \text{ Cal}$$

So heat required > heat lost

Complete ice can't be convert into water

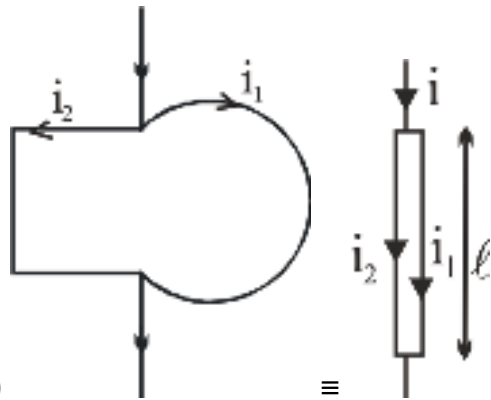
□ Final temperature will be 0°C .

11) As ratio of slit widths = Ratio of intensities

$$\therefore \frac{I_1}{I_2} = \frac{9}{4} \text{ or } \frac{a_1^2}{a_2^2} = \frac{9}{4} \Rightarrow \frac{a_1}{a_2} = \frac{3}{2}$$

$$a_{\max} = a_1 + a_2 = 3 + 2 = 5 ; a_{\min} = 3 - 2 = 1$$

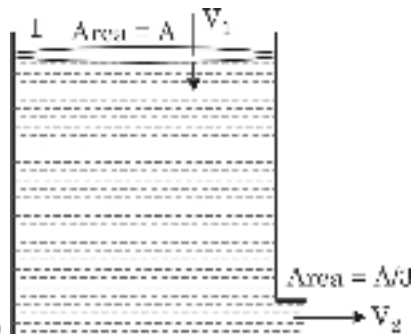
$$\frac{I_{\max}}{I_{\min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{(3 + 2)^2}{(3 - 2)^2} = \frac{25}{1}$$



12)

$$F = Bi_1\ell + Bi_2\ell$$

$$= B\ell(i_1 + i_2) = Bi\ell$$



15)

$$P_A + \frac{1}{2}\rho V_A^2 + \rho gH$$

$$= P_B + \frac{1}{2}\rho V_B^2 + 0$$

$$\Rightarrow P_0 + \frac{1}{2}\rho V_A^2 + \rho gH = P_0 + \frac{1}{2}\rho V_B^2 \quad \dots(1)$$

Equation of continuity

$$AV_1 = \frac{A}{3}V_2$$

$$\Rightarrow V_2 = 3V_1 \quad \dots(2)$$

From (1) & (2)

$$\frac{1}{2}\rho V_1^2 + \rho gH = \frac{1}{2}\rho gV_1^2$$

$$\Rightarrow \rho gH = \frac{1}{2}\rho 8V_1^2$$

$$\Rightarrow V_1 = \sqrt{\frac{gH}{4}}$$

16)

$$\eta = 1 - \frac{T_L}{T_H}$$

$$\frac{1}{2} = 1 - \frac{T_L}{T_H}$$

$$\Rightarrow T_H = 2T_L$$

$$\Delta U = -nC_V\Delta T \quad (\Delta \text{ temperature decreases})$$

$$= 3 \times \frac{3R}{2} \times T_L$$

$$17) \quad v = \frac{2r^2g(\rho - \sigma)}{9\eta}$$

$$v' = \frac{2}{9}r^2g\frac{(\rho - 2\sigma)}{\eta}$$

18)

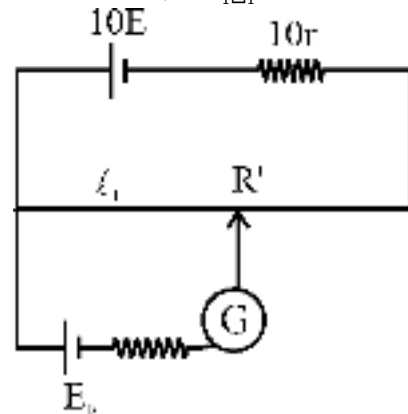
Due to conducting nature of Al eddy currents are produced

19)

In 1st case

$$\rho_1 = \frac{10E}{10r + R'} \times \frac{R'}{L}$$

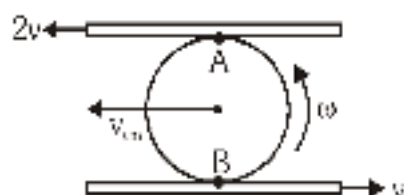
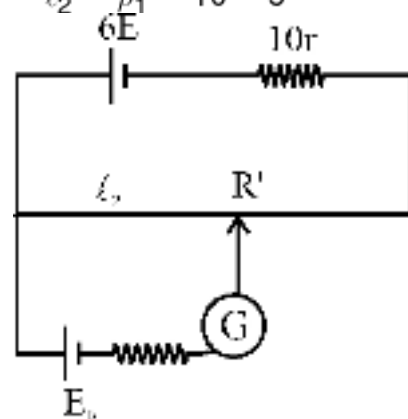
Hence $E_0 = r_1 \square_1$



It's in 2nd case, $\rho_2 = \frac{6E}{10r + R'} \times \frac{R'}{L}$

and $E_0 = r_2 \square_2$

$$\therefore \frac{l_1}{l_2} = \frac{\rho_2}{\rho_1} = \frac{6}{10} = \frac{3}{5}$$



20)

Let angular velocity and linear velocity of centre of mass of disc

be ω and v_{cm} then $v_{cm} + \omega R = 2v$ and $\omega R - v_{cm} = v \Rightarrow 2\omega R = 3v \Rightarrow \omega = \frac{3v}{2R}$

21) $\frac{p \times L}{2} = \frac{mL^2}{12} \times \omega \Rightarrow \omega = \frac{6p}{mL}$

Now $\theta = \omega t \Rightarrow t = \frac{\pi}{2\omega} = \frac{\pi mL}{12p}$

22)

Since speed is constant, hence

$f = mg \sin \theta$ always

23) **Question Explanation:** Calculate the apparent frequency due to Doppler Effect.

Concept: Doppler Effect in Sound.

Solution: When a source approaches a stationary observer, the observed frequency increases. The velocity of the source must be in the same units as the speed of sound.

$v_s = 36 \text{ km/hr} = 10 \text{ m/s.}$

$f' = f \left(\frac{v}{v - v_s} \right) = 512 \left(\frac{330}{330 - 10} \right) = 512 \times \frac{330}{320} = 528 \text{ Hz.}$

Final Answer: Option 2 (528 Hz)

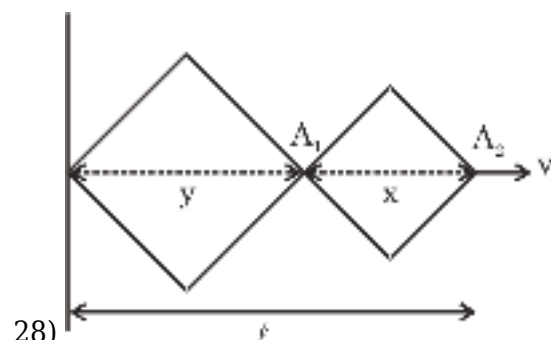
26)

$T = mg - ma \geq \eta mg$

$a \leq g(1 - \eta)$

27) $ma \cos \alpha = mg \sin \alpha$

$\Rightarrow \alpha = g \tan \alpha$



$l = y + x$

$\frac{dl}{dt} = v = \frac{dy}{dt} + \frac{dx}{dt}$

$\Rightarrow \text{also } \frac{y}{x} = \frac{5}{4} \Rightarrow y = \frac{5}{4}x$

$\frac{dy}{dt} = \frac{5}{4} \frac{dx}{dt} \Rightarrow \frac{dx}{dt} = \frac{4}{5} \frac{dy}{dt}$

$$\Rightarrow v = \frac{4}{5} \frac{dy}{dt} + \frac{dy}{dt}$$

$$\Rightarrow v = \frac{9}{5} \frac{dy}{dt} \Rightarrow \frac{dy}{dt} = \frac{5}{9} v$$

$$29) T_{V_A} - T_{V_B} - (2T)v_C = 0$$

$$(7 - 3) = 2v_C$$

$$v_C = 2 \text{ m/s}$$

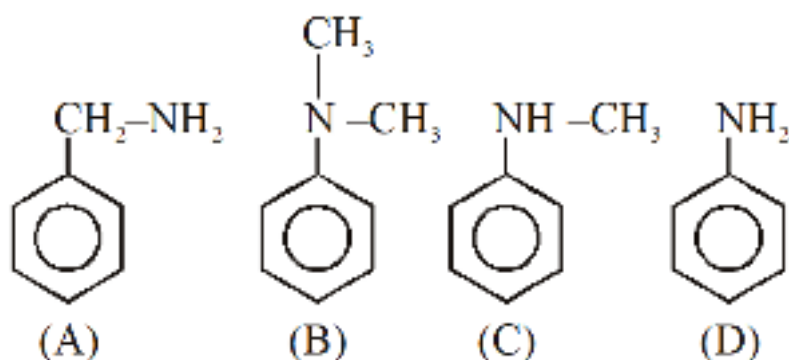
30) **Question Explanation:** The typical energy gap for a semiconductor.

Concept: Semiconductor Energy Gap

Solution: The energy gap in a semiconductor is the energy required for an electron to move from the valence band to the conduction band. This gap is smaller than that of an insulator but larger than that of a conductor. Typically, the energy gap for semiconductors is in the range of 0.1 to 3 eV. Common examples are Silicon (Si) with a gap of 1.12 eV and Germanium (Ge) with a gap of 0.67 eV.

Final Answer: 1 eV

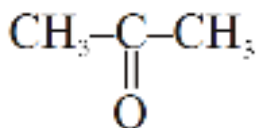
CHEMISTRY



31)

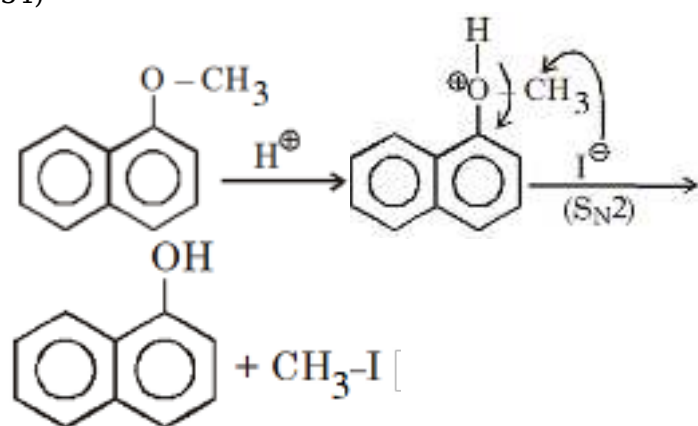
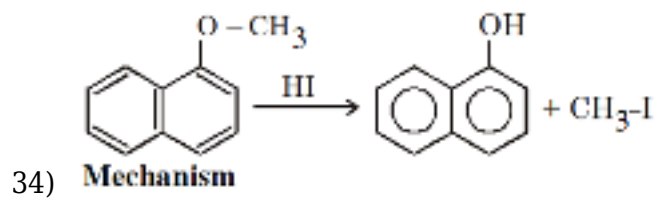
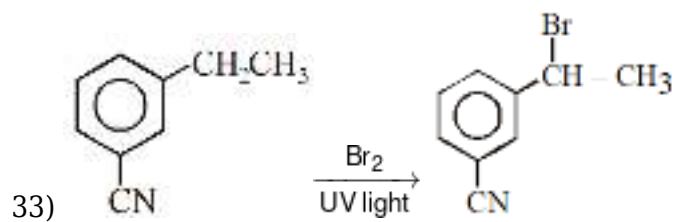
B.S. order (A) > (B) > (C) > (D)

32)

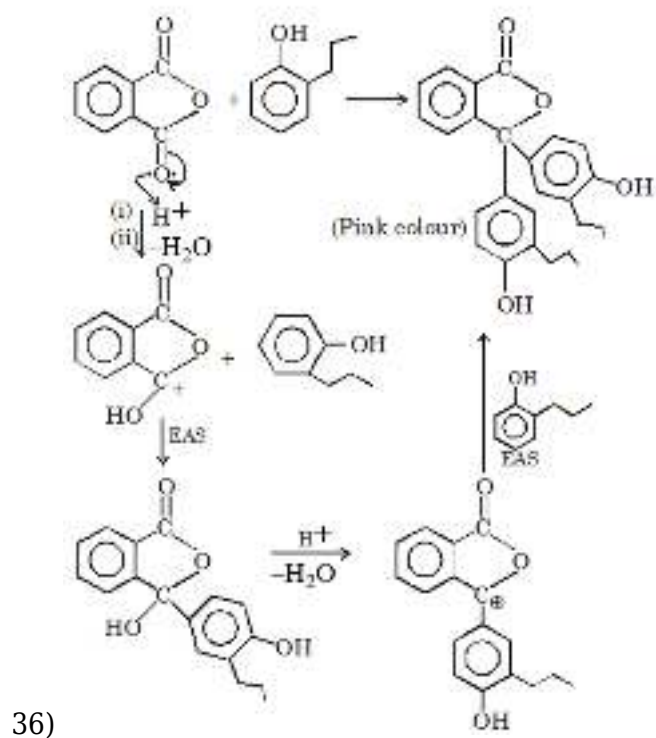


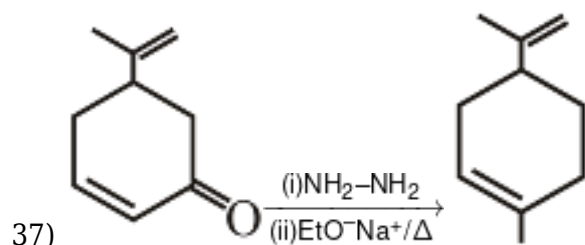
$\text{C}_3\text{H}_6\text{O} = \text{CH}_3-\text{CH}_2-\text{CH}=\text{O}$ &

They are functional group isomerism.

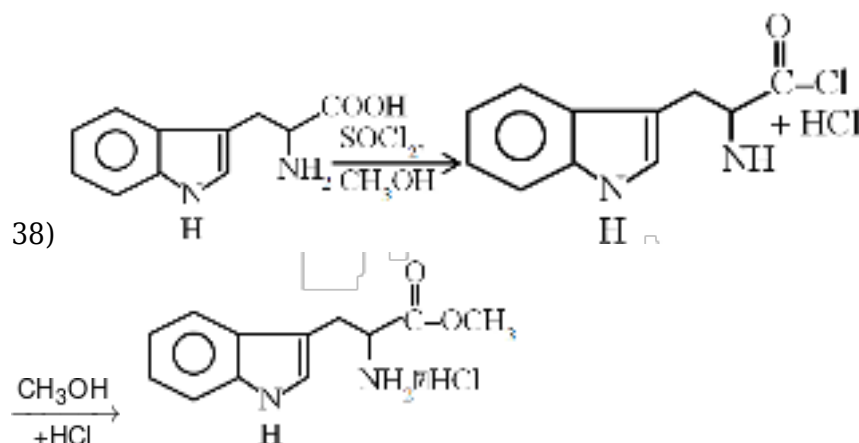


35) Partially deactivated palladised charcoal ($\text{H}_2/\text{Pd}/\text{CaCO}_3$) is lindlar catalyst.

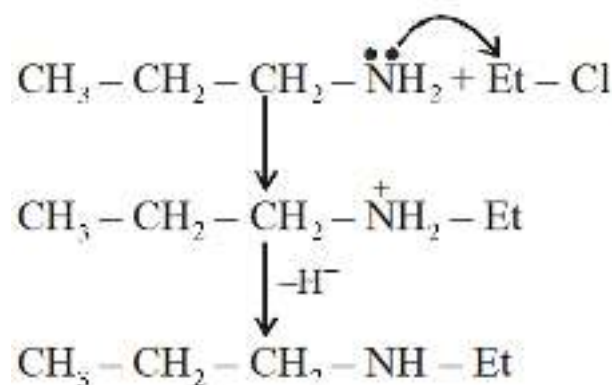




To reduce the carbonyl groups into alkane wolf - kischner reduction is used, without affecting the double bond.



39) It has to be 2° amine because on reaction with benzene sulphonylchloride it gives water in soluble product. As it is formed by ammonolysis of ethylchloride, so it has to be R-NH-Et type.



40) Vitamin helpful in delaying the blood clotting is Vitamin K

41)

$$n_{\text{max}} = \frac{1120}{22400} = 0.05$$

$$\frac{x}{32} + \frac{1.76-x}{48} = 0.05$$

$$x = 1.28$$

$$n_{\text{O}_3} = \frac{0.48}{48} = 0.01$$

$$n_{\text{O}_2} = 0.04$$

$$V_{\text{O}_2} = V_{\text{reduction}} = 0.04 \times 22400$$

$$= 896 \text{ ml}$$

42) **Question Explanation:** Find the new pressure of O_2 when the container volume increases.

Concept: Dalton's Law of Partial Pressures.

Solution: Use Dalton's Law to find the initial pressure of O_2 . Then, apply Boyle's Law to find the new pressure after the volume changes, assuming temperature is constant.

$$P_T = P_{O_2} + P_{H_2O}$$

$$720 = P_{O_2} + 20 \Rightarrow P_{O_2} = 700$$

$$V \rightarrow 4V$$

$$P \rightarrow \frac{1}{4} = \frac{700}{4} = \frac{350}{2} = 175$$

$$\Rightarrow 175 \text{ mm of Hg}$$

Final Answer: (1) 175 mm of Hg

44) Number O^{2-} ions in the unit cell = 4

$$\text{Number of } A^{2+} \text{ ion} = \frac{1}{5} \times (\text{tetrahedral voids})$$

$$= \frac{1}{5} \times (4 \times 2) = \frac{8}{5}$$

$$\text{Number } B^{3+} \text{ ions} = \frac{1}{2} \times (\text{octahedral voids})$$

$$= \frac{1}{2} \times 4 = 2$$

Thus we have A : B : O

$$\begin{array}{ccc} 8 & & \\ \frac{8}{5} & : & 2 : 4 \\ 8 & : & 10 : 20 \\ 4 & : & 5 : 10 \end{array}$$

or

The formula of the compound = $A_4B_5O_{10}$

45) (A) as in case of negative deviation.

(B) ΔG_{mix} is generally positive.

(C) Ideal mixture follows Raoult's law at all compositions, so can not form a constant boiling mixture.

(D) It is theoretically impossible to obtain an ideal solution.

$$46) k = \frac{1}{25} \ln \left(\frac{42-18}{42-30} \right) = \frac{\ln 2}{25} t_{1/2} = \frac{\ln 2}{K} = 25$$

$$47) s = 6.9 \times 10^{-2} \text{ gm/100 ml}$$

$$= \frac{6.9 \times 10^{-2}}{690} = 10^{-4} \text{ mol/100 ml}$$

$$= 10^{-3} \text{ mol/lit}$$

$$K_{sp} = 108 s^5$$

$$= 108 \times 10^{-15} = 1.08 \times 10^{-13}$$

$$48) \Delta S = n C_{p,m} \ln \frac{T_2}{T_1} = 2 \times \frac{5}{2} R \ln \frac{600}{300} = 5 R \ln 2$$

50) **Question Explanation :** Calculate standard reduction potential (E°) for $\text{Ag}/\text{AgI}/\text{I}^-$.

Concept: Metal-Metal ion insoluble salt.

Solution :

$$\begin{aligned} E_{\text{I}^-/\text{AgI}/\text{Ag}}^0 &= E_{\text{Ag}^+/\text{Ag}}^0 + \frac{0.06}{1} \log(K_{\text{SP}}) \\ &= 0.8 + 0.06 \log(8 \times 10^{-17}) \\ &= 0.8 + 0.06[3 \log(2) - 17] \\ &= 0.8 + 0.06[(3 \times 0.3) - 17] \\ &= -0.166 \end{aligned}$$

Final Answer : Option (4)

51) In second period E.A is poor. Thus $\text{S} > \text{O}$.
Nitrogen having stable E.C. lower E.A. then O.

	ℓ_p	$\text{bp}(\sigma)$	Hybridization
SF_4	1	4	sp^3d
XeF_4	2	4	sp^3d^2
I_3^-	2	3	sp^3d
XeF_2	2	3	sp^3d
ClO_3^-	0	3	sp^2
PO_4^{3-}	0	4	sp^3
52) ClO_3^-	1	3	sp^3

53) $\text{Co}^{3+} : 3\text{d}^6 4\text{s}^0$

$\text{d}^6 : t_{2g}^{2,2,2}, e_g^{0,0}$

54) **Explain the question:**

Identify the cause of the red color in ruby.

Concept:

d-d transitions in transition metal impurities.

Solution:

Composition: Ruby is primarily composed of corundum, which is anhydrous aluminum oxide (Al_2O_3).

Impurity: Its characteristic red color is not from the Al_2O_3 itself, but from trace amounts (about 0.5 – 1%) of chromium ions (Cr^{3+}) that substitute for some Al^{3+} ions in the crystal lattice.

Optical Process: The Cr^{3+} ions (d^3 configuration) are surrounded octahedrally by oxide ions. When white light hits the crystal, these ions absorb green and yellow light to promote an

electron from a lower energy d-orbital to a higher energy one—a process known as a d-d transition.

Color Observation: The remaining light that is transmitted or reflected is primarily in the red region of the spectrum, giving the gemstone its deep red appearance.

Final Answer: The correct option is (2).

55)

Concept : Spin pair complex : pairing of e^- take place

(A) $[\text{Co}(\text{NH}_3)_6]^{3+}$ $\text{Co}^{3+} : 3d^6$

NH_3 is SFL is for Co^{3+}

$t_{2g}^{222} e_g^{00}$

d^2sp^3 (spin pair complex)

(B) $[\text{CoF}_6]^{3-}$ $\text{Co}^{3+} 3d^6$ F^- is WFL

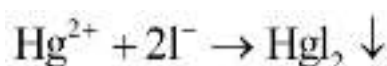
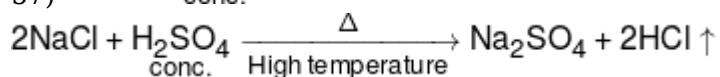
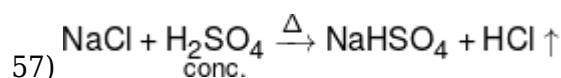
$t_{2g}^{211} e_g^{11}$

sp^3d^2 (High spin complex)

(C) $[\text{NiCl}_4]^{2-}$ $\text{Ni}^{2+} : 3d^8$

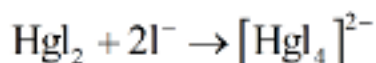
Cl^- (WFL) tetrahedral complex.

56) Ag, Al, Pb, Cu are isolated from sulphide ores.

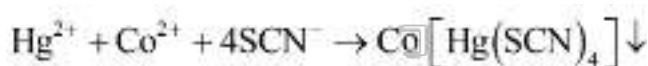


red ppt

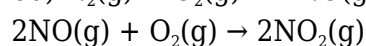
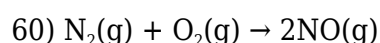
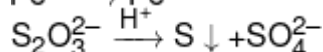
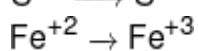
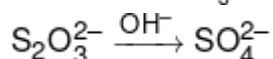
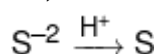
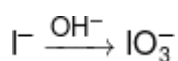
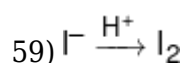
58)



soluble complex



blue ppt



NO₂ damage plant leaves

ENGLISH PROFICIENCY

61) The correct answer is (3)

62) The correct answer is (2)

63) The correct answer is (3)

64) The correct answer is (3)

65) The correct answer is (1)

66) The correct answer is (2)

67) The correct answer is (3)

68) The correct answer is (3)

69) The correct answer is (4)

70) The correct answer is (2)

LOGICAL REASONING

71) The correct answer is (4)

72) The correct answer is (4)

73) The correct answer is (3)

74) The correct answer is (4)

75) The correct answer is (2)

76) The correct answer is (2)

77) The correct answer is (2)

78) The correct answer is (1)

79) The correct answer is (4)

80)

The correct answer is (3)

81) The correct answer is (3)

82) The correct answer is (1)

83) The correct answer is (4)

84) The correct answer is (3)

85) The correct answer is (2)

86) The correct answer is (3)

87) The correct answer is (2)

88) The correct answer is (3)

89) The correct answer is (2)

90) The correct answer is (2)

MATHEMATICS

$$91) 5^{\log x} = 50 - 5^{\log x}$$

$$2 \cdot 5^{\log x} = 50$$

$$5^{\log x} = 25$$

$$\log x = 2$$

$$x = 100$$

$$92) \alpha + \beta = 7, \alpha\beta = 1, \frac{7+3\sqrt{5}}{2} = \alpha, \frac{7-3\sqrt{5}}{2} = \beta$$

$$\begin{aligned}
 93) a_n &= \alpha^n - \beta^n \\
 \alpha^{2023} - \beta^{2023} &- 3(\alpha^{2021} - \beta^{2021}) \\
 \alpha^{2021}(12\alpha) - \beta^{2021}(\beta^2 - 3) \\
 \frac{12(\alpha^{2022} - \beta^{2022})}{2(\alpha^{2022} - \beta^{2022})} &= 6
 \end{aligned}$$

94) Question Explanation:

We have to find least positive integral value of n for the given inequation.

Concept:

This question is based on sum of n terms of G.P.

Solution:

$$\begin{aligned}
 S &= 1 - \left(\frac{2}{3} + \frac{2}{3^2} + \dots + \frac{2}{3^{n-1}} \right) \\
 &= 1 - \frac{2}{3} \left(\frac{1 - \frac{1}{3^{n-1}}}{1 - \frac{1}{3}} \right) = 3^{1-n} \\
 &\Rightarrow \left(\frac{1}{3} \right)^{n-1} < \frac{1}{100} < \left(\frac{1}{3} \right)^4 \\
 &\Rightarrow n - 1 > 4 \Rightarrow n > 5 \Rightarrow n = 6
 \end{aligned}$$

Final Answer:

The correct option is (4)

95)

$$2b = a + c \quad (\text{Q } a, b, c \text{ are in A.P.})$$

$$\text{also given } a + b + c = \frac{3}{2}$$

$$\Rightarrow 3b = \frac{3}{2} \Rightarrow \boxed{b = \frac{1}{2}}$$

$$\text{Also } (b^2)^2 = a^2 \cdot c^2 \quad (\square \text{ In G.P.})$$

$$\Rightarrow \left(\frac{1}{2} \right)^4 = (ac)^2$$

$$\Rightarrow ac = \frac{1}{4} \text{ OR } -\frac{1}{4}$$

$$\text{also } a + c = 1 \text{ as } b = 1/2$$

$$a(1 - a) = \frac{1}{4} \text{ or } -\frac{1}{4}$$

$$a - a^2 = \frac{1}{4} \text{ or } -\frac{1}{4}$$

$$4a - 4a^2 = \pm 1$$

$$4a - 4a^2 - 1 = 0$$

$$4a^2 - 4a \pm 1 = 0$$

$$a = \frac{1}{2} \text{ or } a = \frac{4 \pm \sqrt{16+4.4}}{8} \quad a = \frac{4 \pm 4\sqrt{2}}{8}$$

$$a = \frac{1 \pm \sqrt{2}}{2}$$

$$a = \frac{1 - \sqrt{2}}{2}$$

96) The given equation can be written as

$$3\tan^2 \theta + 2\sqrt{3}\tan\theta - 3 = 0$$

$$\Rightarrow \tan \theta = \frac{-2\sqrt{3} \pm \sqrt{12+36}}{6} = \frac{-2\sqrt{3} \pm 4\sqrt{3}}{6}$$

$$= \frac{1}{\sqrt{3}}, -\sqrt{3}$$

$$\text{Either } \tan \theta = \frac{1}{\sqrt{3}} = \tan \frac{\pi}{6} \Rightarrow \theta = n\pi + \frac{\pi}{6}$$

$$\text{or } \tan \theta = -\sqrt{3} = \tan \left(-\frac{\pi}{3}\right) \Rightarrow \theta = n\pi - \frac{\pi}{3}$$

97)

$$\tan^2 \frac{\theta}{2} = \frac{1 - \cos \theta}{1 + \cos \theta} = \frac{a + b \cos \phi - a \cos \phi - b}{a + b \cos \phi + a \cos \phi + b}$$

$$= \frac{(a-b)(1 - \cos \phi)}{(a+b)(1 + \cos \phi)} = \frac{a-b}{a+b} \tan^2 \frac{\phi}{2}$$

$$98) \quad \frac{1}{2} \int_0^{\pi} f(x) + f(\pi - x) dx = 0$$

$$99) \begin{vmatrix} \lambda - 1 & 2 & 2 \\ 1 & 2 - \lambda & 1 \\ 1 & 1 & 1 \end{vmatrix} = 0$$

$$\Rightarrow (\lambda - 1)^3 = 0 \Rightarrow \lambda = 1$$

100) Let $B(\alpha, \beta)$ and $C(\gamma, \delta)$

$$\frac{\alpha + 1}{2} = -1 \Rightarrow \alpha = -3$$

$$\frac{\beta + 2}{2} = 1 \Rightarrow \beta = 0$$

$$\Rightarrow B(-3, 0)$$

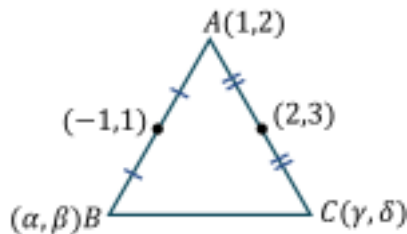
$$\frac{\gamma + 1}{2} = 2 \Rightarrow \gamma = 3$$

Now

$$\frac{\delta + 2}{2} = 3 \Rightarrow \delta = 4$$

$$\Rightarrow C(3, 4)$$

$$\Rightarrow \text{centroid of triangle is } G\left(\frac{1}{3}, 2\right)$$



101) Let the circle is $x^2 + y^2 + 2gx + 2fy + c = 0$ (i)

passing through (a, b)

So, $a^2 + b^2 + 2ga + 2fb + c = 0$ (ii)

Circle (i) is intersecting the circle $x^2 + y^2 = 4$ orthogonally

So, $2g_1g_2 + 2f_1f_2 = C_1 + C_2$

$0 + 0 = C - 4$

$C = 4$

from (ii)

$a^2 + b^2 - 2a(-g) - 2f(-b) + 4 = 0$

Locus of centre is

$a^2 + b^2 - 2ax - 2by + 4 = 0$

$2ax + 2by - (a^2 + b^2 + 4) = 0$

102) The tangent of slope m of parabola $y^2 = 8x$ is

$y = mx + \frac{2}{m}$

if this is also a tangent to $x^2 = -64y$ then

$\frac{2}{m} = 16m^2 \Rightarrow m^3 = \frac{1}{8} \Rightarrow m = \frac{1}{2}$

103) The tangent $\frac{x \cos \theta}{111} + \frac{y}{1111} \sin \theta = 1$, meets the axes at A(111 sec θ , 0) and B (0, 1111 cosec θ)

$\Rightarrow AB^2 = 12321 \sec^2 \theta + 1234321 \cos^2 \theta$

$= 12321 + 1234321 + (12321 \tan^2 \theta + 1234321 \cot^2 \theta)$

Now.

$\Rightarrow AB^2 \geq 12321 + 123421 + 2 \cdot \sqrt{(12321)(1234321)}$

$\Rightarrow AB \geq 111 + 1111 \Rightarrow AB \geq 1222$

104) Here $be = 3 \Rightarrow b = 1$

and $e^2 = 1 + \frac{a^2}{b^2} = 1 + a^2 = 9 \Rightarrow a^2 = 8$

Hence, hyperbola is $\frac{-x^2}{a^2} + \frac{y^2}{b^2} = 1$

$\Rightarrow \frac{-x^2}{8} + \frac{y^2}{1} = 1 \Rightarrow -x^2 + 8y^2 = 8$

105) $T_{r+1} = {}^nC_r (2x)^{n-r} (5y)^r$

$T_r = {}^nC_{r-1} (2x)^{n-r+1} (5y)^{r-1}$

$$\frac{T_{r+1}}{T_r} = \frac{(n-r+1)}{r} = \left(\frac{34-5+1}{r} \right) \left(\frac{10}{6} \right) > 1$$

$$\Rightarrow \frac{35-r}{r} > \frac{3}{5}$$

$$3r < 175 - 5r \quad 8r < 175$$

$$r < \left(\frac{175}{8} \right) \quad r = 0, 1, \dots, 21$$

$$\Rightarrow T_{22} \text{ is largest.}$$

0, 1, 2, 3, 5, 6, 7, 8, 9

Case 1

5			0	
1	7	6	1	= 42

Case 2

3/6			0/5	
2	7	6	2	= 168

106)

Total nos. = 42 + 168 = 210

107) $\log_e a$ is defined for $a > 0$.

$\log \left\{ \sqrt{(4-x^2)/(1-x)} \right\}$ is defined for

$$\sqrt{(4-x^2)/(1-x)} > 0 \quad \dots(1)$$

Now

$$\sqrt{(4-x^2)} = \sqrt{[(2-x)(2+x)]} \text{ is real}$$

if $-2 \leq x \leq 2$.

$\square$ (1) holds if $-2 < x < 2$ and $1-x > 0$

$\square \sqrt{(4-x^2)} = 0$ when $x = \pm 2$

$\Rightarrow -2 < x < 2$ and $x < 1$

$\Rightarrow -2 < x < 1$.

Thus, the domain of $f(x)$ is $(-2, +1)$.

108)

$$= \sin^{-1} \left(\sin \left(\frac{\pi}{2} \right) \right) = \sin^{-1}(\sin(2))$$

= $\pi - 2$

109)

$$\lim_{x \rightarrow 2} \frac{\sqrt{1+\sqrt{2+x}} - \sqrt{3}}{x-2} \times \left(\frac{\sqrt{1+\sqrt{2+x}} + \sqrt{3}}{\sqrt{1+\sqrt{2+x}} + \sqrt{3}} \right)$$

$$\lim_{x \rightarrow 2} \frac{\sqrt{2+x} - 2}{(\sqrt{1+\sqrt{2+x}} + \sqrt{3})(x-2)}$$

Again rationalizing

$$\frac{1}{(2\sqrt{3})^4} = \frac{1}{8\sqrt{3}}$$

= $\frac{1}{(2\sqrt{3})^4} = \frac{1}{8\sqrt{3}}$

110) continuity at $x = 1$

$$\Rightarrow \text{LHL} = \text{RHL} = f(1)$$

$$\Rightarrow a + b = 0 \quad \dots(\text{i})$$

Differentiability at $x = 1$

$$g'(x) = \begin{cases} 6x - \frac{2}{\sqrt{x}}, & x \neq 1 \\ a, & x = 1 \end{cases}$$

$$g'(1-) = f'(1+)$$

$$\Rightarrow 4 = a \quad \dots(\text{ii})$$

from (i) and (ii)

$$a = 4, b = -4$$

$$\begin{aligned} 111) \quad M &= \lim_{x \rightarrow 0} \left(\frac{1 - (f(x))^3}{5 \tan^2 x} \right) \\ &= \lim_{x \rightarrow 0} \left(\frac{(1 - f(x)) (1 + f(x) + f^2(x))}{5 \left(\frac{\tan^2 x}{x^2} \right) x^2} \right) \\ &= \lim_{x \rightarrow 0} \left(\frac{3(1 - f(x))}{5x^2} \right) \\ &= \frac{3}{5} \lim_{x \rightarrow 0} \left(\frac{1 - \cos 2x \cos 4x \cos 6x \cos 8x \cos 10x}{x^2} \right) \\ &= \frac{3}{5} \left(\frac{2^2 + 4^2 + 6^2 + 8^2 + 10^2}{2} \right) \\ &= \frac{3}{5} \times 2^2 \left(\frac{1^2 + 2^2 + 3^2 + 4^2 + 5^2}{2} \right) \\ &= \frac{12}{5} \times \frac{5.6.11}{12} = 66 \end{aligned}$$

$$112) \quad 2 = a + b + \frac{7}{2}$$

$$a + b = -\frac{3}{2} \dots \dots \dots (\text{I})$$

$$y' = 2ax + b = 2a + b$$

$$\text{Now, } x^2 - y + 6x + 10 = 0$$

$$2x - y' + 6 = 0$$

$$y' = 2x + 6 = 0$$

$$y' = 2x + 6 = 2$$

$$2a + b = \frac{-1}{2} \dots \dots \dots (\text{II})$$

Sol (I) & (II)

$$a = 1, b = -\frac{5}{2}$$

113)

$$\text{Let } f(x) = 3 \tan x + x^3 - 2$$

$$f'(x) = 3 \sec^2 x + 3x^2 > 0 \quad \forall x \in \left(0, \frac{\pi}{4}\right)$$

□ $f(x)$ is $\uparrow$

$$\text{Also } f(0) \times f(4) = -2 \times \left(1 + \left(\frac{\pi}{4}\right)^3\right) < 0$$

□ $f(x) = 0$ will have exactly one real root in .

$$114) f(x) = x^3 + x^2 f'(1) + x f''(2) + f'''(3), \quad x \in \mathbb{R}$$

$$f'(x) = 3x^2 + 2x f'(1) + f''(2)$$

$$\Rightarrow f'(1) = 3 + 2f'(1) + f''(2)$$

$$\Rightarrow f'(1) + f''(2) + 3 = 0$$

$$f''(x) = 6x + 2f'(1) \Rightarrow f''(2) = 12 + 2f'(1)$$

$$\Rightarrow -f'(1) - 3 = 12 + 2f'(1)$$

$$\Rightarrow f'(1) = -5; f'''(3) = 6$$

$$f(x) = x^3 - 5x^2 + 2x + 6$$

$$f(2) = 8 - 20 + 4 + 6 = -2$$

$$\begin{aligned} 115) \text{ Putting } x^2 = t, 2x dx = dt, \text{ we get } I &= \int x^3 f(x^2) dx = \frac{1}{2} \int t f(t) dt \\ &= \frac{1}{2} \left\{ t \int f(t) dt \right\} - \int 1 \cdot \left(\int f(t) dt \right) dt \\ &= \frac{1}{2} \left\{ t F(t) - \int F(t) dt \right\} \quad \left[\because \int f(x) dx = F(x) \right] \\ &= \frac{1}{2} \{ x^2 F(x^2) - \int F(x^2) d(x^2) \} \end{aligned}$$

$$116) I = \int_{-\pi/2}^{\pi/2} (\sin^2 x - \sin^4 x) (\sin x - \cos x) dx$$

$$= I_1 + I_2, \text{ where}$$

$$I_1 = \int_{-\pi/2}^{\pi/2} (\sin^3 x - \sin^5 x) dx = 0$$

$$[\square f(-x) = -f(x)]$$

$$I_2 = \int_{-\pi/2}^{\pi/2} (\sin^4 x - \sin^2 x) \cos x dx$$

$$= 2 \int_0^1 (t^4 - t^2) dt \quad [\square f(-x) = f(x) \text{ and } \sin x = t]$$

$$= 2 \left[\frac{1}{5} - \frac{1}{3} \right] = -\frac{4}{15}$$

$$I = 0 - 4/15 = -4/15$$

$$117) (2y + xy^3)dx + (x + x^2y^2)dy = 0$$

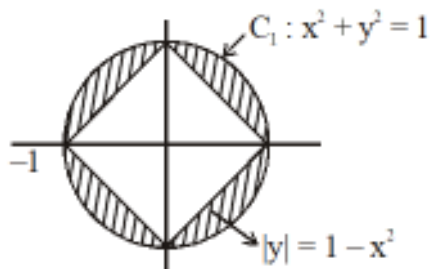
$$2ydx + xdy + xy^3dx + x^2y^2dy = 0$$

$$[y(2xdx) + x^2 dy] + (x^2y^3 dx + x^3y^2 dy)$$

$$d(x^2y) + \frac{1}{3}d(x^3y^3) = 0$$

$$x^2y = -\frac{1}{3}x^3y^3 + C$$

$$x^2y + \frac{1}{3}x^3y^3 = C$$



118)

$$4 \int_0^1 \sqrt{1-x^2} - (1-x^2) dx$$

$$\text{Area} = \frac{3\pi - 8}{3} \text{ sq. units.}$$

$$119) \begin{bmatrix} 1 & 2^n - 1 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 511 \\ 0 & 1 \end{bmatrix}$$

$$2^n - 1 = 511$$

$$\Rightarrow n = 9$$

120) $\hat{a}, \hat{b}$ and $\hat{c}$ are unit vectors. Now

$$x = |\hat{a} - \hat{b}|^2 + |\hat{b} - \hat{c}|^2 + |\hat{c} - \hat{a}|^2$$

$$= 2(\hat{a} \cdot \hat{a} + \hat{b} \cdot \hat{b} + \hat{c} \cdot \hat{c}) - 2\hat{a} \cdot \hat{b} - 2\hat{b} \cdot \hat{c} - 2\hat{c} \cdot \hat{a}$$

$$= 6 - 2(\hat{a} \cdot \hat{b} + \hat{b} \cdot \hat{c} + \hat{c} \cdot \hat{a}) \quad \text{..(i)}$$

$$\text{Also, } |\hat{a} + \hat{b} + \hat{c}| \geq 0$$

$$\text{or } \hat{a} \cdot \hat{a} + \hat{b} \cdot \hat{b} + \hat{c} \cdot \hat{c} + 2(\hat{a} \cdot \hat{b} + \hat{b} \cdot \hat{c} + \hat{c} \cdot \hat{a}) \geq 0$$

$$\text{or } 3 + 2(\hat{a} \cdot \hat{b} + \hat{b} \cdot \hat{c} + \hat{c} \cdot \hat{a}) \geq 0$$

$$\text{or } 2(\hat{a} \cdot \hat{b} + \hat{b} \cdot \hat{c} + \hat{c} \cdot \hat{a}) \geq -3$$

$$\text{from (1) } x \geq 9$$

121) Here, the required plane is

$$a(x - 4) + b(y - 3) + c(z - 2) = 0$$

$$\text{Also } a + b + 2c = 0 \text{ and } a - 4b + 5c = 0$$

Solving, we have

$$\frac{a}{5+8} = \frac{b}{2-5} = \frac{c}{-4-1} = k$$

$$\frac{a}{13} = \frac{b}{-3} = \frac{c}{-5} = k$$

Therefore, the required equation of plane is

$$-13x + 3y + 5z + 33 = 0$$

122) Projection of line $\frac{x}{2} = \frac{y-1}{2} = \frac{z-1}{1}$ on a plane P is $\frac{x}{1} = \frac{y-1}{1} = \frac{z-1}{-1}$.

□ Plane through these lines is perpendicular to the plane P.

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 2 & 1 \\ 1 & 1 & -1 \end{vmatrix} = -3\hat{i} + 3\hat{j}$$

Normal to the plane determined by the given lines is

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -3 & 3 & 0 \\ 1 & 1 & -1 \end{vmatrix} = -3\hat{i} - 3\hat{j} - 6\hat{k}$$

□ Direction ratios normal to the required plane is

□ Equation of the plane is $x + y + 2z - 3 = 0$ as it passes through $(0, 1, 1)$.

Its distance from origin is $\sqrt{\frac{3}{2}}$.

123) simple and use $|z| = \sqrt{x^2 + y^2}$

If $z = x + y$

$$124) z = \frac{\sqrt{3}}{2} + \frac{i}{2} = \cos \frac{\pi}{6} + i \sin \frac{\pi}{6}$$

$$\Rightarrow z^5 = \cos \frac{5\pi}{6} + i \sin \frac{5\pi}{6} = \frac{-\sqrt{3} + i}{2}$$

$$z^8 = \cos \frac{4\pi}{3} + i \sin \frac{4\pi}{3} = -\left(\frac{1 + i\sqrt{3}}{2}\right)$$

and

$$\Rightarrow (1 + iz + z^5 + iz^8)^9 = \left(1 + \frac{i\sqrt{3}}{2} - \frac{1}{2} - \frac{\sqrt{3}}{2} + \frac{i}{2} - \frac{i}{2} + \frac{\sqrt{3}}{2}\right)^9$$

$$= \left(\frac{1 + i\sqrt{3}}{2}\right)^9 = \cos 3\pi + i \sin 3\pi = -1$$

125)

Question Explanation: Calculate probability of an event using Binomial Distribution.

Concept: Binomial Probability Distribution

Solution: In a family of 5, having a birthday on Sunday is a "success" (p) and any other day is a "failure" (q). We use the formula $P(X = r) = {}^nC_r \cdot p^r \cdot q^{n-r}$ for exactly r successes.

Total members (n) = 5, Successes (r) = 2

Probability of Sunday (p) = 1/7, Not Sunday (q) = 6/7

$$P(X = 2) = {}^5C_2 \cdot (1/7)^2 \cdot (6/7)^3$$

$$P(X=2) = 10 \cdot \frac{1}{7^2} \cdot \frac{6^3}{7^3} = \frac{10 \cdot 6^3}{7^5}$$

Final Answer: $\frac{10 \times 6^3}{7^5}$ (Option 4)

$$\begin{aligned} 126) \quad & \frac{3}{5} \times p \times \left(1 - \frac{1}{2}\right) + \frac{3}{5} \times (1-p) \times \frac{1}{2} + \frac{3}{5} \times p \times \frac{1}{2} = \frac{2}{5} \\ \Rightarrow & \frac{3}{5} \left[\frac{p}{2} + \frac{1}{2} - \frac{p}{2} + \frac{p}{2} \right] = \frac{2}{5} \\ \Rightarrow & p + 1 = \frac{2}{3} \Rightarrow p = \frac{2}{3} \end{aligned}$$

$$\begin{aligned} 127) \quad & \sigma^2 = \frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n} \right)^2 \\ 4 &= \frac{100}{n} - \left(\frac{20}{n} \right)^2 \\ \Rightarrow & n^2 - 25n + 100 = 0 \\ \Rightarrow & n = 5 \text{ or } 20 \end{aligned}$$

$$\begin{aligned} 128) \quad & f(x) = \int_1^x |t| dt \\ & f'(x) = |x| \times 1 = \begin{cases} -x : \frac{1}{2} \leq x < 0 \\ x : 0 \leq x \leq 1/2 \end{cases} \\ & \text{at } x = 0, \text{ neither maximum nor minimum.} \\ f(1/2) &= \int_1^{1/2} |t| dt = - \int_{1/2}^1 t dt = -\frac{1}{2} [t^2]_{1/2}^1 = -3/8 \\ f(-1/2) &= \int_1^{-1/2} |t| dt = - \left\{ \int_{-1/2}^0 -t dt + \int_0^{1/2} t dt \right\} \\ &= -5/8 \end{aligned}$$

Hence, greatest value of $f(x) = -3/8$

129) $f(x)$ is differentiable for all $x \in \mathbb{R}$
 $\Rightarrow f(x)$ is continuous for all $x \in \mathbb{R}$
 at $x = -1$, LHL = RHL

$$\begin{aligned} \lim_{x \rightarrow -1^-} (px + q) &= \lim_{x \rightarrow -1^+} (px^3 + x + 2q) \\ \Rightarrow -p + q &= -p - 1 + 2q \\ \Rightarrow q &= 1 \\ \text{at } x = -1, \text{ LHD} &= \text{RHD} \\ \Rightarrow \lim_{x \rightarrow -1^-} (P) &= \lim_{x \rightarrow -1^+} (3px^2 + 1) \\ \Rightarrow p &= 3p + 1 \Rightarrow p = \frac{-1}{2} \end{aligned}$$

Final Answer: option (3)

$$130) A^2 = 3A - 4I$$

$$A^4 = 9A^2 - 24A + 16I$$

$$A^4 = 9(3A - 4I) - 24A + 16I$$

$$A^4 = 3A - 20I$$